CHEMICAL
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ENGINEERING

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THE COVER

• The striking photograph by Ritase of Philadelphia which greets you from our front cover this month is a view of a barytes furnace in the plant of the Krebs Pigment & Color Corp. at Newark, Del. It is reproduced here through the courtesy of *The DuPont Magazine*.

THIS MONTH

• Those of our readers who have visited Washington recently or who plan to attend the A.C.S. convention later this month will have a real interest in the large-scale demonstrations of dust explosions carried out at Arlington, Va., under the supervision of Dr. David J. Price, chief of the chemical engineering division of the Bureau of Chemistry and Soils. Two of his associates present in this issue, for the first time, the underlying engineering considerations involved.

• Fifty years in the ammonia-soda alkali manufacture has probably given Edward N. Trump a broader perspective than that of any other man who has been identified with this important industry. His article reflects an industrial philosophy that might well be emulated in other fields of chemical endeavor.

NEXT MONTH

• Speaking of "Depression Achievements," next month's *Chem. & Met.* starts the ball rolling with a chemical engineering account of the important developments in New Mexico that have finally assured the potash independence of the U.S.A. Another article describes an electrochemical plant in the Pacific Northwest that serves the process industries in that rapidly growing territory. Others of timely interest will deal with the new white paper industry in the South and with asphalt emulsions.

• That special-theme number on Chemical Engineering Achievements, originally planned for April, has now been scheduled for May at which time we have a proposal to make which should be of interest to every chemical engineer and executive in process industries. Watch for it!

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CONTENTS FOR MARCH, 1933

VOLUME FORTY NUMBER THREE

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109

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& METALLURGICAL
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McGRAW-HILL PUBLISHING COMPANY, INC.

S. D. KIRKPATRICK, Editor

MARCH, 1933

NOW, UNITED, WE GO AHEAD!

EVENTS of the past fortnight have done much to subordinate competitive and partisan interests in order to accomplish a common purpose—to carry on in meeting the urgent demands of a national emergency. We have only started to fight but the very fact that we have started on a united front is encouraging. For almost the first time since the fateful crash of 1929, there is a hopeful change in public psychology. It is as if we recognized at last that all the processes of tearing down must be stopped and the drastic and disastrous industrial deflation brought to an end. The time has come when we must begin to rebuild and that process is one that calls for consolidation of energy and purpose, for cooperation in every line of industry.

For more than three years we have concentrated our attention on individual, company, or industry problems and, it must be admitted, that the record of achievement is not a source of pride. We have talked a lot about the basic problems of the country but our actions, which speak louder than words, have all been directed toward only one end—self preservation. Wage and salary cuts and long layoffs have curtailed purchasing power. Price cutting and cutthroat competition have robbed us of profits. All of this has been a part of the vicious descending spiral in which we lost sight of our fundamental interdependence—the fact that as a nation we cannot continue to think and act in terms of any group or any given industry. It took the banking crisis to make us realize that after all we have only one interest to serve, that of the welfare of the country as a whole.

We have full assurance that this is the motive that will guide those men in Washington who are charged with the responsibility of our national government. They must have the confidence and support of all of us as individual citizens. But there is also a responsibility to the public interest on the part of industry. It, too, is something we must recognize and support. The public demands that American industry returns to the highest ethical plane of business practice. Competition can no longer be ruthlessly destructive of the gains that were built up through constructive cooperation over a period of years. Fair wages to labor, fair prices for raw materials, fair profits to the manufacturer and fair returns to the investor can only be fair and beneficial to the consumer. All of these desirable ends will be attained when industry turns once more to the ideals of cooperation and builds for the public interest.

* * *

In the chemical engineering profession and in most of the industries it serves there has been no serious breakdown in ethical and business standards and practices. For the most part, prices have been maintained at fair levels and with any return toward normal production, profits to capital and wages to employees should be advanced proportionately. But it must be apparent to all of us that we should not only continue on such a basis but by precept and example, we must aid in the process of rebuilding public confidence in American industries and institutions. We have reached the end of deflation and now can turn all of our energies in the direction of reconstruction—once industry is really convinced of that fact.

EDITORIALS

Can't We Eliminate This Cause for Chiseling?

GOVERNMENTAL extravagance lies at the root of more of our present-day difficulties than are immediately apparent on the surface. It can be shown, for example, that one of the basic causes of that evil we know as "chiseling" is the fact that much of the bank credit normally available for the use of industry has been diverted to governmental financing. In the present situation the federal, state and municipal authorities can borrow at absurdly low interest rates. The result is a temptation to sell short-term paper to finance rapidly mounting deficits. Bankers wishing to keep their institutions as liquid as possible rush in to purchase these government obligations and thereby actually encourage extravagance in new expenditures or in the maintenance of existing services that are no longer needed.

Industry through its taxes must pay considerable of the bill for local, state, and federal government. When more people come to a realization that inflation of government is balanced by a corresponding deflation in industry, there will be a much greater insistence on economy. Progress in that direction would help to return the flow of bank credit to industrial channels and thus eliminate one of the underlying causes for price cutting.

Who Will Speak For Process Industry?

PROCESS INDUSTRY should have a competent spokesman to set forth its needs and interests with respect to power utilization and the development of natural resources in the Tennessee River Valley. Last month we explained why that problem is important, and how partially advised public officials may go astray for the lack of adequate technical advice. The situation in Washington, is, of course, now largely overshadowed by the problems of banking, budget balancing, and tax readjustment by the Federal authorities. But this merely postpones; it does not eliminate the problem.

Many process industry groups could well join in having a study made of the Tennessee Valley situation. A committee of outstanding individuals, like the Transportation Committee originally headed by Calvin Coolidge, would be highly desirable. Such a committee could formulate a disinterested set of findings regarding the extent to which reforestation, utilization of forest products and water power, and development of mineral resources is both practical technically and in the public interest.

May we suggest that such a committee could very profitably be organized and financed for a simple straight-forward study? It could be supported, for example, by the fertilizer industry, electrochemical and electrometallurgical enterprises, by the principal groups using forest products such as the hardwood distillation industry, and by others. If each such group would contribute modestly to the cost of such an inquiry it would undoubtedly be possible to enlist a group of eminent, public-spirited individuals to form the committee and receive the advice of the supporting groups and others who might find any interest in the matter.

A long study or a very costly one would not be essential. A few thousand dollars spent within a few months might bring out convincingly to the public those real opportunities for advance which may be found in the Tennessee Valley, and show the impracticability of others that have had popular support because of the partisan propaganda. Who will take the lead in such an enterprise?

Should We Put Alcohol in Motor Fuel?

THOSE in our profession who may have talked rather loosely about a chemical solution for the farmer's problem may shortly have an opportunity to see the practical working out on a national scale of just such an experiment. Technically there is no valid reason why alcohol cannot be made from excess grain and thereafter mixed with some proportion of gasoline and used as a motor fuel. But from an economic and practical industrial point of view such a program as originated in the Middle West and has now moved on to Washington is fraught with most serious difficulties, both in policy and execution. If the former is to be decided for us by legislative or executive fiat, the problems confronting the chemical engineer are greatly simplified. We can go ahead and produce the desired products in existing plants or erect new ones even though we may have grave misgivings about their immediate benefit to the farmer and their ultimate effect on chemical industry.

Some who argue in favor of the plan say that it is not to be judged solely on an economic basis. Economic soundness, they say, is relative for we must compare it with domestic allotment and other plans for farm relief many of which are admittedly unsound. That, in our opinion, is not a valid excuse for running counter to the dictates of reason. If what we do to help the farmer is going to rise and plague him in years to come, the time to stop is before we start. Certainly, it would be short-sighted for chemical industry to build, even with R.F.C. money, a string of state or privately operated alcohol plants that would continue to plague that business long after the present emergency has passed.

Our considered opinion having in mind the best interests of both the alcohol and petroleum industries, is that chemical engineers should discourage and

oppose any drastic program involving the erection of new plants to supply a major portion of the motor fuel requirements of the country. If a fair interpretation of the public interest demands that the experiment be tried, then it should be started in existing plants which are now operating at less than a quarter of capacity and could readily be changed over to the use of grain at a total expense of not more than $3,000,000. That, it seems to us, is a fair wage considering the long odds that are against the ultimate success of any program that opposes what seem to be sound economic principles.

Proper Venting May Prevent Secondary Explosions

SECONDARY explosions are more serious than primary. Often it is the secondary which is called "the explosion." If we stop the primary puff there will be no big aftermath.

These fundamental principles long vaguely recognized lend special importance to the chemical-engineering study presented in this issue by the engineers of the Bureau of Chemistry and Soils. Their work gives us a rational basis on which to forecast construction requirements if one is to control the dust explosions that inevitably may arise even in the most carefully planned and managed factory where combustible dusts must regularly be handled. If buildings are constructed according to proper principles for venting, the bad consequences of these inevitable small "pops" are minimized and explosions of the proportion of a disaster need not follow.

Only last month the world was horrified by what occurred at Neunkirchen, Germany, where an entire community was wrecked by the explosion of equipment in the byproduct-coke department of a small steel works. Full technical reports are still lacking, but the more reliable news services seem to indicate clearly that here again a minor fire and explosion in the tar-handling facilities was the initial cause of the secondary blast which did such terrible damage. This would seem to demonstrate that the principles of explosion venting, studied primarily for dusts by these Bureau engineers, could well be considered in any works handling flammable gases or vapors which may occasionally become mixed with air in explosive proportions. Too much care and forethought cannot be given to this vital consideration of safe plant operation.

Secondary Materials in Chemical Competition

OF LATE it has become evident that secondary chemicals are exerting more than their traditional effect on primary markets. Recovery has been vastly improved in many instances and is being brought even closer to theoretical perfection. Just witness the case of a new sludge-acid process which is said to take any unseparated sludge acid, regardless of strength, and convert it into a clean SO_2. The gas is then put through a contact plant for the production of close to 100 per cent of water-white acid of any strength from 98 per cent, up. Makeup is readily supplied in the form of sulphur for the production of acid equal to or larger in amount than the original acid. Although the process is still too new to hazard predictions, it may conceivably put refiners in the acid business, at least to the extent of supplying all of their own requirements.

There are other cases where recovered chemicals have clearly become secondary materials, with all that secondary status implies. An enterprising oil refiner has been successfully marketing a special pickling acid for which the user pays a premium because of the content of certain inhibitors that naturally find their way into the acid during its original use in the treatment of distillates. Most viscose rayon makers are selling a dilute contaminated caustic soda which is recovered from their steeping presses. Investigation of dialysis processes for purifying such caustic is being actively pursued. And there are other heavy chemicals and certain solvents that may soon require consideration for their secondary status. Although sweeping generalizations cannot be made because each example is likely to be peculiar to itself, nevertheless a generalization that is both timely and safe is that such developments are to be watched. Just as metal producers give heed to secondary supplies, chemical management must watch the signs and portents where they bid fair to influence primary production.

Potash Independence Guaranteed for 1934

POTASH MINING is to be undertaken by a second responsible and well-financed company which is now starting to sink a shaft near Carlsbad, N. M. Early this summer operations are expected to be well under way. Reliable estimates indicate full-scale production before the end of the calendar year. It is important, therefore, to take new stock of our potash situation.

By the beginning of the active shipping season in 1934 the United States capacity for production of potash will apparently be about equal to domestic requirements. The major producing units will be susceptible of considerable further expansion. It is evident, therefore, that national independence of foreign sources of potash is an assured thing, even though improved agricultural conditions, increased fertilization, and a rejuvenated fertilizer business should re-establish as great a demand as in the peak of the past decade. American industry can, without an unwarranted spirit of chauvinism, take great pride in this achievement of the potash producers.

Venting Dust Explosions

By HYLTON R. BROWN AND RICHARD L. HANSON

Chemical Engineers
Bureau of Chemistry and Soils
Washington, D. C.

SOME dust explosions are certain to occur in industries which necessarily produce combustible dusts. The serious consequences of such accidents are minimized by the proper use of light construction, hinged panels, or large glass and sash areas that give quick venting at low pressures. Built up pressures produce undue spread of flame and secondary explosions, which are responsible for the major part of the life loss and damage to structure and equipment.

Safety codes prepared by the dust-explosion hazards committee of the National Fire Protection Association under the leadership of the chemical engineering division of the Bureau of Chemistry and Soils recommend for venting at lower pressures several types of swinging vents. Some are held shut by weight or inertia alone; others use a light friction catch. A friction device also is used to resist the opening of the vent throughout its swing and to hold it open. Still other vents, particularly sash, may be pushed from the frame in such manner that the explosion may pass out on all sides. This opening is limited by folding or sliding brackets at four points. Another type of outlet is formed by the application of louvres.

It is not the purpose of this article to compare the merits of the various types of swinging vents, but rather to show their desirability, as compared with the use of fixed glass. All of the types have their peculiar advantages, depending upon the type of structure, the cost, and the frequency and severity of the explosions to be anticipated.

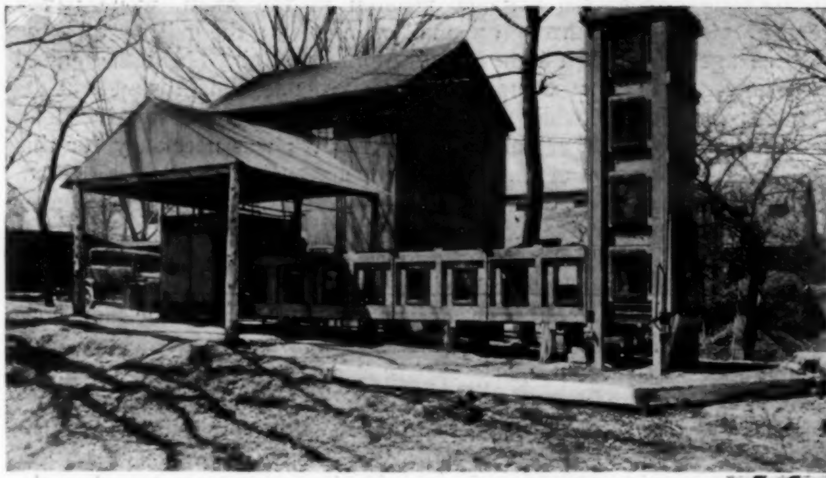
In order to obtain accurate data on the venting area required for various explosive dusts with the different types of venting, special equipment has been installed at the Arlington, Va., experimental station of the U. S. Department of Agriculture. This experimental structure, in which the venting of dust explosions can be studied, consists of a room, a gallery, and a tower. The fixed glass windows in the structure provide a factor of safety by breaking when the venting area is not sufficient to prevent the development of excessive pressures. Dust may be sprayed into suspension in the air within the structure from hemispherical cups by jets of compressed air. Ignition is produced by a glowing electric heater coil. Pressures produced by the explosions are recorded by rubber diaphragm manometers, installed at appropriate points in the structure, to record pressures up to 800 lb. per sq.ft.

The method of making the tests is as follows: The charge of dust to be used is placed in the cups, the vents to be used are unlatched or set to operate, the manometers are placed and the ignition coil is heated to its approximately constant temperature. The compressed air line leading to the jets above the dust cups is then opened, and as the dust cloud forms around the coil, the explosion occurs.

Too much dependence may not be placed on fixed glass as a means of venting explosions in industrial plants. Standard factory sizes, 12x18 in. and 14x20 in., of double strength A-quality glass set in steel sash and wooden frames has in a number of cases withstood pressures of more than 300 lb. per sq.ft.; and in several cases pressures of 400 lb. per sq.ft. or more were recorded without breaking the glass. Assuming 300 lb. per sq.ft. as the pressure such glass could be expected to withstand, the total pressure exerted on a 4x8 ft. window sash would be almost five tons. Such pressures are capable of causing serious damage to both structure and equipment. This fact explains why in a number of factory explosions, the entire steel sash has been blown out of its anchorage in the building wall and indicates the necessity of providing some form of explosion vents capable of operating at much lower pressure.

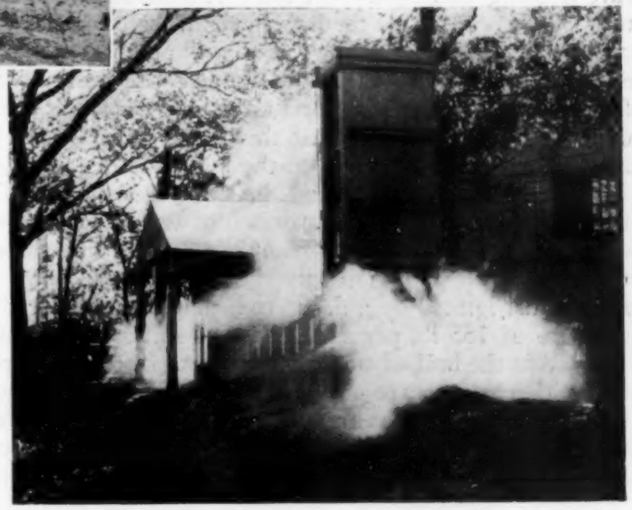
Dust cups and electric ignitor. Eight 6 in. cups in each of the three sections of the structure permit dust-cloud formation independently or together

Assuming that the breaking of glass indicated the pressure at which structural damage would occur, several series of tests were planned to determine: (1) venting area per unit of volume necessary to prevent structural damage; (2) effect of location and distribution of vents; (3) effect of differences in size and type of ignition; (4) reduction of



Experimental explosion structure. The room 4x5x5 ft.; the gallery 2.5x2.5x20 ft.; the tower 3x3x12; total volume 333 cu.ft. Vents on room 0.1 to 1.55 sq.ft. each are hinged metal doors and pivoted sash of approximately 7 sq.ft. of glass. Gallery has 8 hinged door roof vents 1 sq.ft. each, and 8 fixed glass windows 1.3 sq.ft. each. Tower includes one swinging panel 7 sq.ft., three hinged doors 1.55 sq.ft. each, adjustable vent on top and four glazed windows 1.7 sq.ft. each

Typical explosion without breakage of glass



pressure due to increase in venting area; (5) effect of outside glazing, and (6) effect of scoring glass to reduce the breaking strength. Steel doors of different sizes, operating only against their own inertia, were used as vents.

A rather lengthy series of tests were performed to determine the venting area which would be required in a room or building in order to prevent the breaking of fixed glass, or the building up of pressures exceeding 300 lb. per sq.ft., which as previously stated was arbitrarily taken to be the point at which structural damage would occur. Starting with the room alone, which had a volume of 100 cu.ft., 58 explosions of starch dust were produced, with different arrangements of the vent openings. Although it was found that a number of factors had a bearing on the results obtained, the general conclusion reached was that to provide satisfactory venting for an explosion of starch dust in a cube-shaped or approximately square room of small size, 3 sq.ft. of vent for each 100 cu.ft. of volume would be necessary.

With grain dust slightly different results were obtained. Sixty-six explosions were produced, with different arrangements of the vent openings. The amount of vent opening in the room was gradually reduced to the point at which breakage of glass occurred. Based on the results obtained, it is recommended that in cube-shaped or approximately square rooms of small size, 1¼ sq.ft. of vent be provided for each 100 cu.ft.

Although no extensive series of tests were made with other dusts, there were enough to indicate the pressures produced in comparison with starch and grain dust. The results obtained with sugar, wood flour, sulphur, cork, powdered milk, soap powder, and similar products indicated that the venting necessary for these dusts ranges between the requirements for starch and grain dust.

When the tests were extended to include the gallery and tower, the results indicated very definitely that the shape of the room is an important factor to consider in determining the amount and the location of the vents required to release explosion pressures without structural damage. It was found, for instance, that an explosion propagating through the gallery, which is 2½x2½x20 ft., produced a gun barrel effect with rapidly increasing pressures. Glass along the side of the gallery would be broken before these pressures could be released through openings at the end of the gallery of the size recommended for cube-shaped rooms.

A few shots in the tower indicated that the same conditions met in long narrow galleries also existed in deep, small-diameter bins, and venting at the top only, in the ratio recommended for rooms, would not be satisfactory.

In the room tests with the ignition at the center and the vents centrally located in each panel, little could be done in the way of studying the effect of location and distribution of vents. There was an indication, however, that one or two large vents were more effective than several smaller ones totaling the same vent area—this probably being due to the resistance offered to flow through small openings.

The effect of location and distribution of vents was most successfully studied in the gallery tests. In these tests the gallery was used as a closed unit. The ignition in each case was located as shown in the center of the gallery section below vents G and H. The manometer was located as shown. Grain dust was used throughout.

Table I—Gallery Tests (Grain Dust)

Vents Used	No. of Tests	Total Vent Areas, Sq.Ft.	Glass Broken	Average Pressure	Vent per 100 Cu.Ft.
NP	11	2.0	7	356	1.6
½G	9	0.5	None	214	0.4
NP and ½M	3	2.5	None	141	2.0
HKMP (part opening)	2	1.0	None	312	.8
HKMP (part opening)	3	1.7	None	153	1.35
All Vents (small opening)	2	1.5	None	172	1.2

From this table it may be seen how vents N and P at the opposite end from the ignition are inadequate pro-

Publication of this report is authorized by the Secretary of Agriculture; a complete statement of experimental work to date is being published in *N.F.P.A. Quarterly*, April 1933.

tection, although they more than conform to the total vent required for a cubical structure. Conversely, ½G provided all the vent necessary to prevent the breakage of glass. Here the vent was much less than that required in a cubical structure of similar volume. This vent, being so close to the ignition source, dissipated the pressure rapidly and permitted a very slow propagation toward the closed end of the gallery. This type of protection can not be advised because the exact point of ignition in an industrial plant explosion is not predetermined, but it does show how much more effective the vent becomes when it is located close to the ignition source.

When the venting was distributed along the gallery and either four vents or all eight were used, the amount of safe opening corresponded closely to that for the room tests. This is shown in the lower part of Table I. As the venting of the gallery at the end opposite the ignition was extended to include NP and ½M, sufficient protection was furnished to lower the pressures and prevent glass damage. It may be seen that this is not entirely due to the increased vent, but also to the increased distribution.

This advantage of using distributed vents is still further emphasized in a comparison of several explosions of starch dust. With 3¼ sq.ft. of vent evenly distributed throughout the length of the gallery an explosion of starch dust ignited by a flash from the room produced a pressure of 155 lb. per sq.ft. With 4 sq.ft. of vent distributed in the half of the gallery remote from the source of ignition an average pressure of 470 lb. per sq.ft. was recorded. When all vents along the gallery were closed and the end left entirely open to provide 6¼ sq.ft. of vent, large amounts of glass were broken and pressures were produced, exceeding the manometer scale but estimated to be as high as 1,500 lb. per sq.ft.

If any elongated structure is to be protected against dust explosions, whether it be tower, gallery, or L-shaped building, the building should be sectioned or zoned into cubical units. The vents may then be applied for each of these units at the limits of the unit itself. That is, vents should be in the amount recommended for the particular dust, and for the volume of the cubical unit and should be located in the roof or outer wall enclosing the cubical unit or zone being protected. From this it may be seen that when a dust hazard is located in the center of a building between floors where the distance to an outer wall exceeds the height of the ceiling, venting is difficult and complicated.

Undoubtedly the size and type of ignition is responsible for many of the differences noted in dust explosion tests. (Lower Limits of Concentration for Explosion of Dusts in Air, by L. J. Trostel, and H. W. Frevert, *Chem. & Met.* Vol. 30, Jan. 28, 1924.) No attempt will be made in this article to draw a fine distinction between different types of ignition. A marked difference should be noted, however, between what may be termed primary and secondary ignitions. For instance, explosions in the gallery and tower occurred much more quickly, and the pressures rose much more rapidly, when dust clouds in those parts of the structure were ignited by a flash from a primary explosion in the adjoining room than when the coil alone was used as the source of ignition. This difference is believed to be due to the fact that the flash from the primary ignition in the room, when partly vented through a small opening into the gallery, took the form of a flame 8 ft. or more in length. The flame ignited the dust cloud at about the same time throughout its length while the coil in the gallery itself produced an ignition at only one point, and it was necessary for this ignition at the coil to propagate through the dust cloud, relatively a much slower process which produced a slower pressure rise.

Explosions of grain dust ignited by a coil in the gallery produced an average pressure of about 180 lb. per sq.ft., when 3 sq.ft. of vent was provided. Under the same conditions except that the ignition was produced by a flash from a primary explosion in the adjoining room, the average pressure was about 280 lb., and in one case glass was broken. With grain dust ignited by the coil in the gallery a pressure of 235 lb. per sq.ft. was recorded, with 2⅝ sq.ft. of vent. With the same vents, when the dust cloud was ignited by a flash from the room, the pressures averaged more than 400 lb.

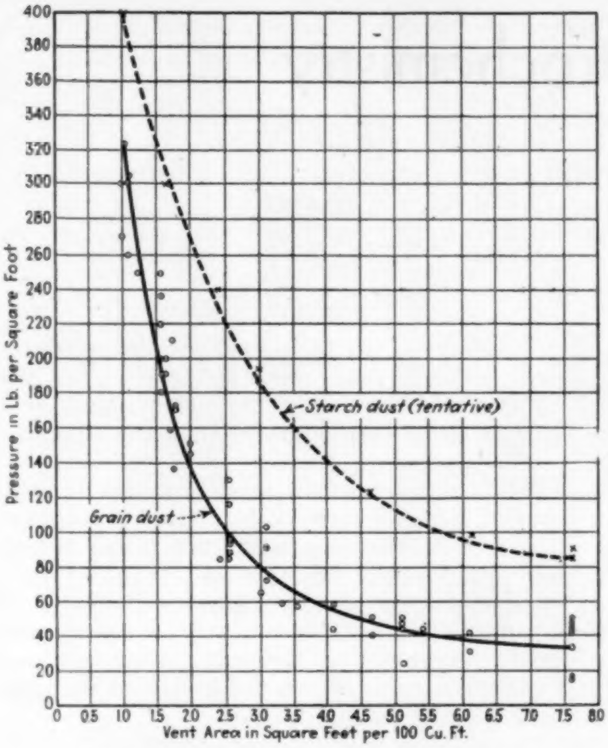
When the vent in the gallery was reduced to 2¼ sq.ft., an explosion of grain dust ignited by a coil in the gallery produced a pressure of 400 lb. per sq.ft. With the same amount of vent and a similar dust cloud ignited by a flash from an explosion in the room, the pressure was 475 lb., and two windows were broken.

Results indicate clearly the added difficulty encountered in trying to vent a secondary explosion, and emphasize the advantage of providing sufficient openings at all points in the structure to properly vent any primary explosion at the origin. By such means the secondary explosion may be wholly prevented.

The venting area per unit of volume previously recommended in this article is believed to be the minimum that should be used to provide protection against structural damage. Where additional protection is desired or necessary to prevent damage to equipment, extra vents should of course be provided. In fact any additional venting that can be provided will pay good dividends should an explosion occur, because as shown in a study of the tests, the explosion pressures drop rapidly as the venting area is increased beyond the minimum amount recommended. To show this reduction the pressures recorded with different vent openings have been plotted and curves drawn.

The data given in the diagram are for cube-shaped units or small square rooms, and pending the securing of additional test data application to long narrow rooms and galleries or high towers and bins can be based only on data from a few shots in the gallery and tower. These tests indicate that the provision of vents in approximately the same ratio of area to volume as used in the room will be satisfactory, provided the venting area is distributed in such a way that each cubical unit of the structure has its share of vent. It is presumed that the increasing of this evenly distributed venting area will result in correspondingly reduced pressures, as was the case in the room.

Diagram of gallery



Reduction of pressure due to increase of vent area in cubical structure

During the making of tests to determine methods of venting or otherwise reducing the pressures that would be built up in a room or building where dependence had been placed on fixed glass for venting, it was suggested that outside glazing might permit the glass to be blown out of the frames at a pressure below that required for breaking. Accordingly, the steel sash was reversed, and a series of tests arranged to determine the pressure at which glass would be blown out when placed in the frames from the outside with clips only, with plastic putty, and with commercial putty.

These tests with clips were to determine their relative resistance rather than to determine their practicability. The average pressure at which glass was blown out when clips alone were used was about 50 lb. per sq.ft. Plastic putty of a standard type with four auxiliary clips was similarly tested. This glaze required but 100 lb. per sq.ft. to blow out the glass. In like manner, commercial putty with four clips per pane was tested after a few days aging. This required about 200 lb. per sq.ft. to blow out the glass. Considerable added resistance is anticipated when glazing with commercial putty is tested from six months to a year after installation.

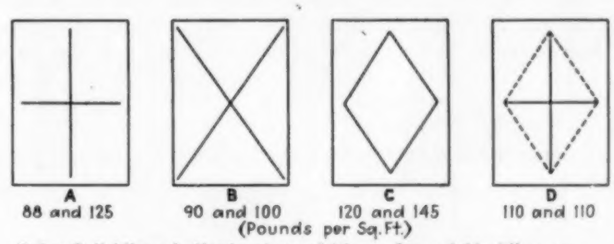
These results indicate that outside glazing with plastic putty has certain advantages worth considering in providing venting area for the release of explosion pressures. Outside glazing, however, probably would be more difficult and more expensive, and replacement of broken panes would be more hazardous.

Another method suggested for reducing the pressure at which fixed glass would break and thus provide additional venting for an explosion before destructive pressures were reached was to score or partly cut the pane in such a way that comparatively low pressures would fracture the glass. From the results of the few tests it was concluded that this method had some merit. Undoubtedly the depth and the design of the cut will affect to some extent the breaking strength of scored glass. It is believed, however, that such cuts will permit glass to be blown out at from one-half to one-third the pressure normally required to break it.

It should be understood that such scoring of glass is not recommended as a substitute for movable vents but rather as additional protection where large areas of fixed glass are used in addition to the recommended amount of vent. Information is not available concerning the possibility of fractures occurring in scored glass due to extreme or sudden changes in temperature or to building vibration, but no breakage from this cause occurred during the tests.

The series of dust explosion venting studies originally planned have not been completed and only two dusts have been used to any extent, but it is felt that the results obtained and reported in this article are sufficiently definite to indicate that:

1. It is possible to vent dust explosions without structural damage.
2. Fixed glass offers too much resistance to permit dependence upon it alone for the release of explosion pressures without structural damage.
3. Many types of venting equipment, hinged doors, windows, and panels may be satisfactorily used to release explosion pressures provided sufficient venting area is used.



Breaking strength of scored glass

4. Vents near the source of ignition are more effective than those located some distance away.
5. The venting area required varies for different dusts.
6. Secondary explosions are more difficult to vent than primary explosions.
7. A definite reduction in pressure results as the venting area is increased.
8. Pressures may be released by lowering the resistance of fixed glass by means of outside glazing or by scoring.

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March of Electrochemistry

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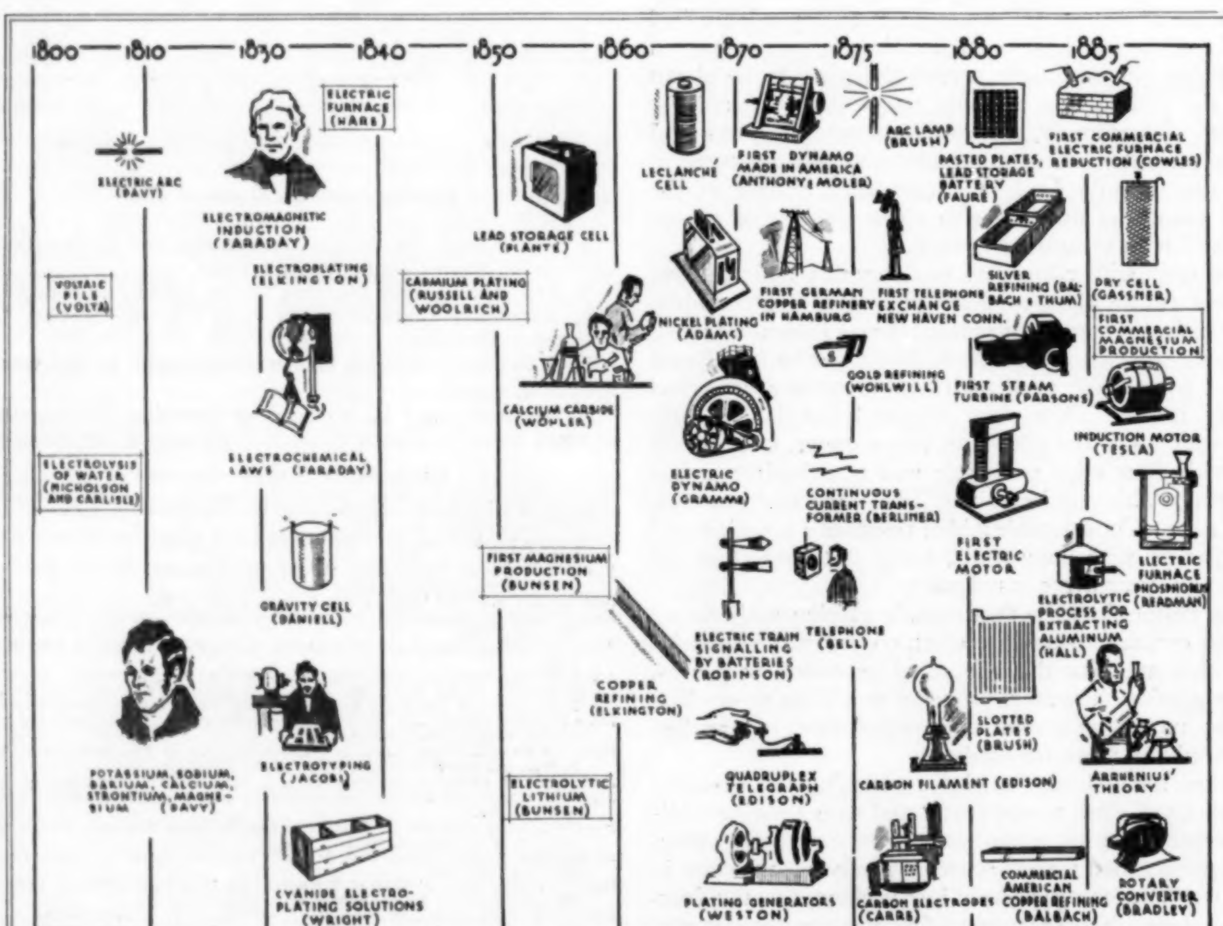
THE COMMERCIAL developments of the electrochemical industries in their present day extent is less than 50 years old, but the entire basic science and art go back little more than a century.

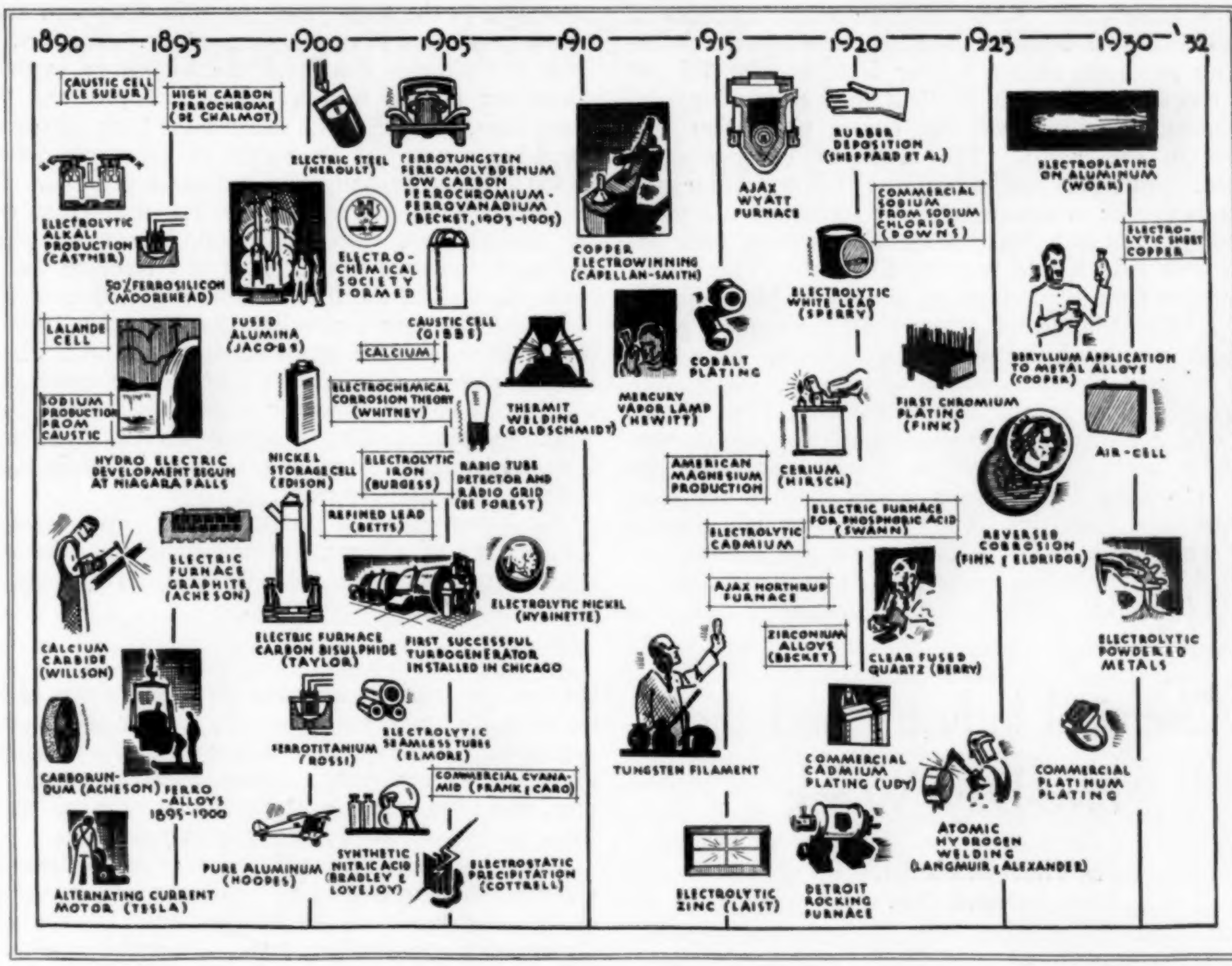
Electrochemical processes require electrical energy, the existence of which was to all intents and purposes unknown before 1800 when Volta discovered his voltaic pile. A number of these couples together was the first source of electrical energy used to break up water into its elements and provide for Davy's arc in 1807. Davy's assistant, Faraday, discovered electromagnetic induction as well as the underlying laws of the action of electrical energy on chemical substances and solutions in 1834.

Daniell's chemical battery, invented in 1836, furnished a new and more powerful source of electrical energy. Through its use came electroplating, developed by the Elkingtons in England from 1836 on; and electrotyping by Jacobi in 1839. Wright in 1840 worked out the basis for plating solutions. In 1849 we find cadmium plating discovered and only rediscovered some 70 years later when commercial quantities of the metal became available. Bunsen made magnesium in 1852 and lithium in 1855.

In 1859 Planté learned how to store electricity in his lead storage cell. Although Wöhler made calcium carbide in 1862, it was 30 years later when trying to make aluminum that Willson, an American, stumbled on it again, to start that present day gigantic industry. In 1868 Leclanché made his cell or battery, which in modified form is the present day dry cell. Adams commercialized nickel plating in 1869 to make possible the nickel plated handle-bar of the bicycle age.

Then began a new era of larger quantities of power. The electrical generating machine was built. In 1875 Anthony and Moler made the first American dynamo. Weston in 1874 had built a low voltage plating genera-





tor, and five years later Edison produced the carbon filament incandescent lamp and Brush the carbon arc lamp. In 1876 Bell's telephone could operate with batteries; and Carré, a Frenchman, had learned how to make carbon electrodes. Elkington learned how to refine copper electrolytically. Some four years later the Balbachs and the Thums were producing refined copper in the United States and working out mechanisms to refine silver.

The year 1882 brought forth the first electric motor. Electrical machinery development moved apace. Parson's steam turbine in 1884 and Bradley's rotary converter in 1887 were important developments.

Hall in 1885 worked out his aluminum process. Gassner in 1888 had converted Leclanché's cell into its present day dry form. Castner needed sodium to make aluminum, and in 1890 had invented a cheap method to make the metal. His mercury type alkali-chlorine cell is operating today. Acheson hit upon silicon carbide, the first synthetic abrasive. Tesla, another of Edison's co-workers, made a motor driven by alternating current.

Electric furnaces and electrolytic cells were still in their infant stages but ready to grow up at a tremendous rate. Under the leadership of Adams, the power plants at Niagara Falls were begun and blossomed in 1894. Here was power in large quantities.

But new industries did not cease to be born. In 1895 Moorehead made 50 per cent ferrosilicon, so needed by the steel maker. An overheated silicon carbide furnace in 1896 gave Acheson graphite, a lubricant superior to the natural mineral. The twentieth century was born but not before Jacobs had learned to melt aluminum oxide to bring forth a new, better, and stronger "emery," another abrasive.

At the dawn of the century, Edison brought forth his nickel storage cell. Hoopes in 1900 outlined the steps for the manufacture of pure aluminum from Hall's product; but he did not live to see it commercially produced almost a quarter of a century later.

Conscious of the growing importance of the field, a group of leaders came together in 1902 to organize the American Electrochemical Society, which was to grow so international in scope that the term "American" was later dropped. Becket, two years later, developed new and purer ferro-alloys through the use of silicon instead of carbon. Whitney proposed the electrochemical theory of corrosion. Betts refined lead, Burgess iron, and Cottrell brought forth his method of electrostatic precipitation of dust and fume.

The year 1905 brought the cyanamide process of Frank and Caro, whose work was the basis of the tremendous nitrogen fixation plants of the U. S. Government in the World War, when nitrogen compounds were sadly needed for explosives; as well as the basis of the peace time uses of cyanamide, fertilizers, ammonia, cyanides, and urea. DeForest in 1906 with his radio tube detector opened up the new field of electronics to the world. Hybinette in 1906 had worked out the kinks of commercial nickel refining.

Then came a lull. Chile had tremendous amounts of low grade copper deposits. Millions were spent in working out processes to win copper from ores of 1.5 per cent copper, culminating in 1912 in a tremendous development bringing forth the lowest production cost copper in the world. The realm of electrowinning opened. Anaconda and others in 1915 applied related methods to zinc to produce a purer form, and two years later byproduct cadmium. Magnesium was of great interest. In 1915 it sold for over $1 per lb. The annual production from byproducts of salt brines has grown to over 1,000,000 lb., to sell at one-third the original price.

Again industry had caught up with itself. New tools were needed. Electric furnaces of increased utility were designed to find greater application—the Ajax Wyatt in 1916; Northrup's ingenious high-frequency furnace the same year; and before the World War ended the Detroit rocking furnace now widely used in the nonferrous metal foundries. The year 1919 brought electrolytic white lead. The following year the Downs cell allowed the production of sodium from cheap salt instead of caustic. Electric furnace phosphoric acid was successful in the same year. In 1921 Sheppard and his co-workers learned how to plate rubber. The next year, Fink at Columbia converted the laboratory method of chromium plating into a commercial process. Some years later, in 1925, Fink learned the trick of reversing corrosion. Antiques thousands of years old were restored electrochemically and museums rejoiced. Berry in 1922 used the electric furnace for clear fused quartz for optical uses. Langmuir and Alexander split the hydrogen molecule apart, to let it recombine and thus make the basis of the atomic hydrogen welding torch.

In the last few years light metals again, this time beryllium and lithium, are demanding attention. Platinum is now plated; aluminum is given many coatings and colors; the copper producer makes his articles directly from the refining tank. Powdered metals, made electrolytically, had tremendous development in bearings, automotive and machinery parts.

The electrochemical industries are today more than 10 per cent of all our chemical industries, the annual value of products being $350,000,000,—truly giant steps over a century of achievement.

Chemical Industry and the Five-Day Week

By FRED D. HARTFORD
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SUPERVISION of the factory over the week-end has always been a somewhat troublesome problem in smelters, chemical plants and other continuous process industries. With the advent of the five-day week for the office force and the maintenance and yard crews, it is becoming still more difficult. When the latter departments work on Saturday mornings, they can usually give their respective parts of the burden sufficient momentum to carry them through until Monday morning. But when the week-end is increased to three nights and two days, 63 hours in all, supervisory strategy and tactics, especially in maintenance, are put to a severe test.

Back in the days when the week-end was only 44 hours long, a certain large process plant, operating 24 hours a day and 7 days a week, found it advisable to have present on Saturday afternoons and the Sunday day shifts a suitable member of the supervisory personnel. This temporary supervisor shouldered the responsibility of keeping the plant up to the proper pitch and of taking charge in a general emergency.

At the beginning of each year in this plant a schedule was arranged so that each man eligible to be called knew in advance when he was supposed to serve. A holiday falling on a week day was treated in the same manner as a week-end; thus, over a period of time each man would serve his proper proportion of such days. The schedule also provided that no man's week-end or holiday service should interfere with his summer vacation.

In this plant all department heads on salary—the assistant superintendent, the process foreman, the department process foremen, the research supervisor, the chief chemist, the maintenance engineer, and three assistant maintenance engineers—were eligible for this week-end command. For the week-end routine maintenance of plant motors and pumps, three electrical maintenance men, who lived near the plant and who were paid straight time, worked alternate Sunday mornings.

If a minor repair became necessary when the maintenance engineer or any of his assistants were in week-end charge, they would do the job, perhaps with the help of the electrical maintenance man. On larger repairs, they called in a few workmen of miscellaneous crafts who lived nearby and who happened to be at home. When other week-end supervisors found repairs necessary, they were usually forced to telephone a maintenance foreman who assembled the necessary crew.

In case of a major breakdown on Saturday afternoon or Sunday, a general call for maintenance men was broadcast and a truck dispatched to gather them in. At such times, no strict lines between maintenance crafts were drawn, the intention being to get as many mechanics as possible who knew gas and corrosives well enough to avoid injury and to trust that they could use a wrench, a pick, or a chain block to get things going again.

With the coming of the longer week-end, the temporary supervisors took charge of the plant for the full Saturday and Sunday day shifts. In addition, there was always on duty at least one maintenance man who, when not engaged on some minor repair job, was assigned to painting or some similar routine work.

Incidentally, the five-day week is one of the most valuable innovations ever to befall the maintenance department in a seven-day plant, for it forces the department to study and plan for each repair. The net result of the five-day week on maintenance should be an appreciable lowering of maintenance costs.

The experience of being responsible for the operation and safety of the entire plant and of having close contact with the process operators for a considerable time is a most valuable one for the members of the supervisory personnel privileged to share in it. The five-day week has made such experience even more valuable.

Improving Automatic Control by Recorder Chart Interpretation

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IN THE AVERAGE process plant, successful operation depends largely upon the accuracy with which the processes are carried out. This inherent necessity for accuracy has led to the development of automatic devices for the control of temperature, pressure, flow, time and other variables—devices which are most useful when they supplement, not replace, careful human observation. The design of industrial control instruments has followed the trend of demand and the plant engineer now has available many "standard applications" for use with well-known processes. But, when he steps across the border from the region of the known to that of the unknown, he will find little to help him.

In an effort to set up certain basic principles of control, to assist in devising new controls, and to simplify the improvement and more effective use of the old ones, a method of chart reading is described herein. Successful chart interpretation must be based on a consideration of *all* the information a chart can give, including the factor of *time*. This time factor is the least well known but the most important feature of satisfactory control.

The underlying mechanism of every control application consists of some mechanical or electrical means for turning on or off a source of supply at a definite "set" point. This supply may be flowing water, steam, gas, electricity, coal, air, a process fluid, or, in fact, anything which can be regulated to maintain the desired process conditions. But the mere fact that a control instrument will regulate the flow is not a sure indication that actual control will result, as will be clear from what follows:

1. If the effect of a change in the control supply results in an almost immediate response from the responsive element, any type of controller which will so regulate the supply source will accomplish control.

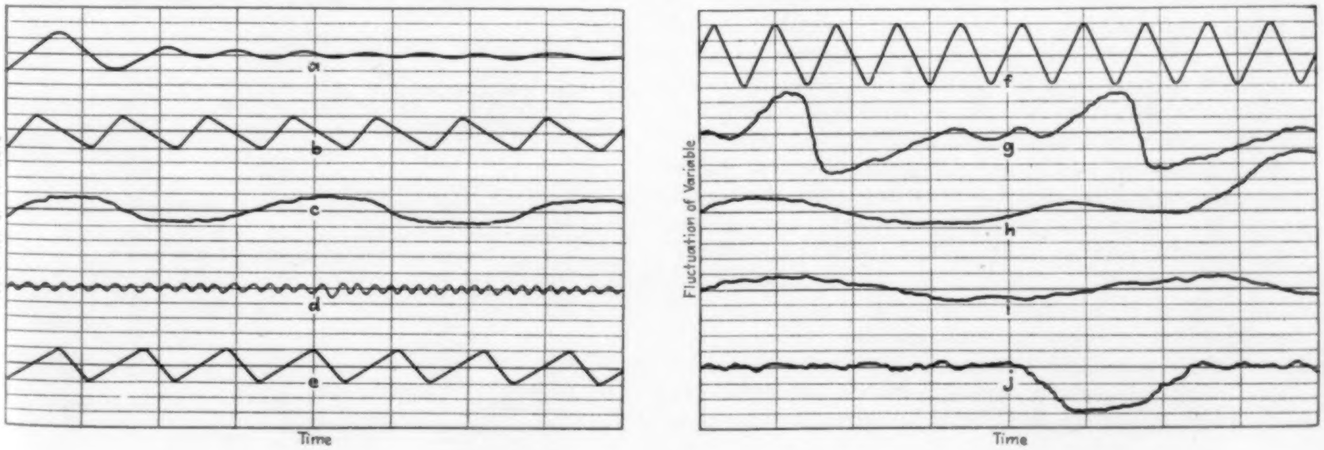
2. If, however, a change in the supply of control medium does not bring an immediate response from the responsive element, then a "time lag" exists, and the actual degree of control obtained will fluctuate more widely than the operating points of the instrument.

We have an example of this second condition in the simplest form of space heating where a number of large pipe coils are placed along the walls, with the responsive element (thermostat) in the center of the room. In such a case there will be a considerable interval between the turning on of the steam and the moment when its effect is first "felt" by the thermostat. As the heating continues the air temperature in the vicinity of the thermostat will gradually approach the set point, but by the time the steam is turned off, the temperature adjacent to the coils will be much too high. Hence, the average temperature will overshoot the set point, both ascending and descending, and the resultant swings may be very wide.

This simple and familiar example shows how time enters into the problem of controlling the temperature of the air in a room. By inference it also shows that the

Fig. 1—Typical Charts Illustrating Various Sorts of Automatic Control

(*a*) Perfect balance in apparatus and controller
(*b*) Apparatus heats more rapidly than it cools
(*c*) Good control in a slow-heating and -cooling apparatus
(*d*) Perfect rapid-action control
(*e*) Apparatus cools more rapidly than it heats
(*f*) This control would be better with a faster controller
(*g*) What happens when a fast controller is used on a slow apparatus
(*h*) Supply fluctuation in the auxiliary system of Fig. 3
(*i*) Perfect control on very slow apparatus
(*j*) What happens in a perfect system with failure of supply source



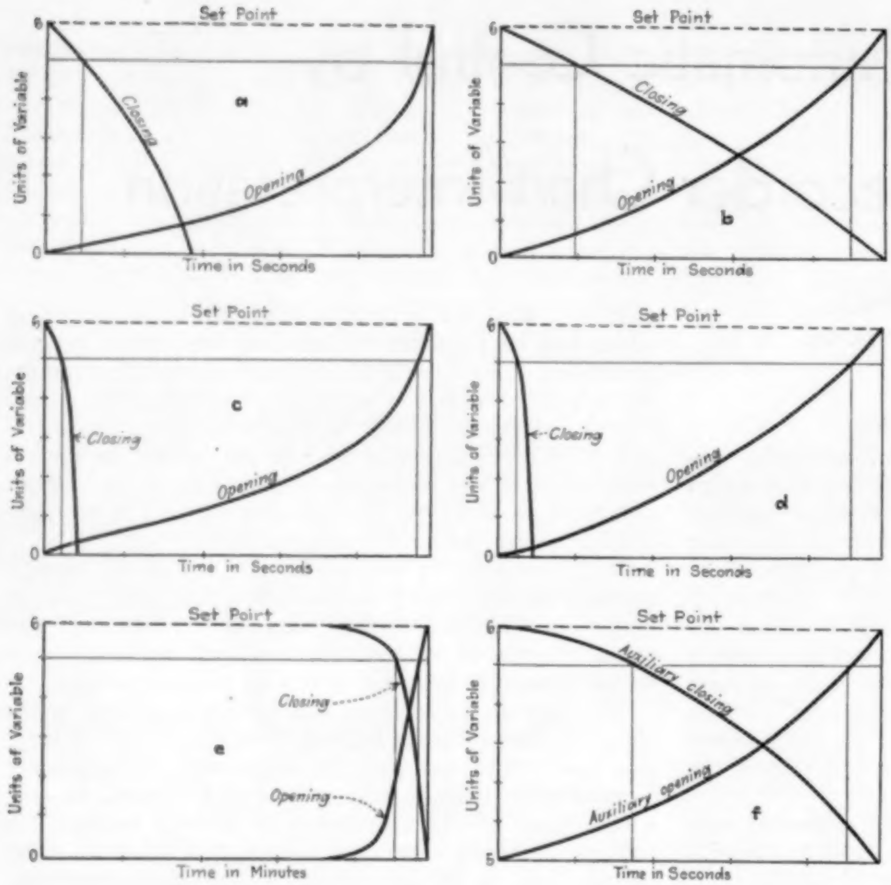


Fig. 2—Six Classes of Problem Met in Control and the Methods of Solving Each

(*a*) Rapid rise and slow fall; use group (1) controls; probable chart type, 1*b*

(*b*) Rapid rise and slower fall; use group (1) or (2) controls; probable chart type, 1*b*, *c* or *d*

(*c*) Rapid rise and equally rapid fall; use only group (1) controls, preferably fastest types; probable chart type, 1*a* or *d*

(*d*) Slower rise than fall; use group (2) controls (increase in supply source should be provided); probable chart type, "as is," 1e, altered, 1*d*

(*e*) Serious time lag; see text on time-lag applications

(*f*) Serious time lag corrected by auxiliary source of supply; for control, see text on time-lag applications; probable chart type, 1*i* with steady supply source; or 1*h* when source varies

time factor may likewise affect the control to be expected from *any* system.

An understanding of the subject of chart interpretation is dependent, first, upon a preliminary knowledge of the types of devices to be controlled and their characteristics; and, second, upon a general insight into the available controllers with which to control them. For that reason we will discuss both at some length, particularly with reference to their times of *response* and of *action*.

Equipment Types

Typical of the devices in chemical plants which may give the greatest trouble in controlling are steam-jacketed kettles, air-drying ovens and gas coolers and washers. The reason for the difficulty is largely assignable to the fact that such equipment is uniformly slow to respond to a change in the source of (heat) supply: kettles, because of their very small ratio of heating surface to mass; ovens, because of slow conduction and convection; and coolers and washers, because of the slow transfer of heat from air to water, and unfavorable physical contour.

In contrast to these slow-responding devices, several types of apparatus respond to changes in the supply source at a very satisfactory rate of speed. Among these are horizontal, steam, atmospheric vulcanizers; flow-control systems with oversized pumps; and benzol and other light-oil stills. It is obvious that the treatment of these two groups of devices must somehow differ if satisfactory control is to be had.

The principal construction features of automatic controllers are known to most instrument users, but there has been as yet no grouping of these instruments according to available differential settings, and according to speeds of action between their extreme limits of differential. The differential of an instrument, it should be noted, is its range, expressed in the units controlled, between the points at which it fully opens and fully closes the control valve. This range is usually adjustable. The speed of action of a controller is the speed with which the mechanism responds to an increase or decrease of temperature (or other condition) at the responsive element, and within the zone defined by the extreme limits of the differential, as set. This velocity is not only affected by the design and adjustment of the instrument, but is (in the case of temperature controllers) limited by the speed with

Controllers Classed by Speed and Differential

Type	Controller	Differential,* Per Cent of Range Max.	Min.	Speed
	Group (1) Controllers, Fast-Action Types			
A	Air operated, vapor filled	5	1	Highest
B	Do., mercury filled	10	1.5	High
C	Do., gas filled	20	3	Fairly high
D	Do., expansion stem	20	3	Fairly high
E	Electric, thermocouple	Almost as desired		Potentiometer type not faster than once in 10 sec.
F	Contact thermometers and recorder-controllers	Almost as desired		High
G	Auxiliary-operated (steam or water) using pilot valves	20	1-5	High
	Group (2) Controllers, Slow-Action Types			
H	Vapor tension self-contained	100	5(?)	Slowest
I	Type *D* above	20	3	Can be made very slow
J	Type *E* above	Almost as desired		Can be made very slow by infrequent contacting
K	Type *C* above	20	3	Can be slowed by pilot valve adjustment
L	Combined instruments (recorder-controllers)	50	1	Can be made very slow

* Accuracy of percentages not guaranteed.

which heat is taken up by the responsive element itself.

A grouping of instrument types as described in the preceding paragraph has been made in the accompanying tabulation. With this and the foregoing explanations for background we can proceed to constructive chart reading. Let us first consider Fig. 1 which is an attempt to show in "strip" form a number of typical sorts of control which are actually obtained in chemical and other plants.

In Fig. 1, record *b* shows a chart which proves that the apparatus used was more ready to increase (in heat) than to decrease. The relative speeds in each direction, of course, are measured by the time required for each half cycle. Record *e* shows a similar but reverse condition, in which the temperature of the apparatus decreases more rapidly than it increases. Both conditions shown by these records are caused by inherent properties of the apparatus, but can either be corrected by repiping or, more simply, compensated by a proper choice of controllers.

Once a record of the control given by the existing controller has been obtained, the next step in the investigation consists in checking the chart record by actual test measurements of the apparatus, turning the source of supply on and off manually, and keeping accurate time records of the result. From the tabulation of such a test (cross checked against the charts) curves similar to those of Fig. 2 can be plotted in a self-evident manner. These curves give us complete data for remedial procedure, and permit the development of a relation between the observed time of response of the equipment and the speed of action of a suitable control.

It is obvious that if the time of response be short, the time of action of the controller must be equally rapid. This statement has as a corollary the one that if the time of response be long, a rapid-action controller will

Fig. 3—Auxiliary supply for correcting time lag

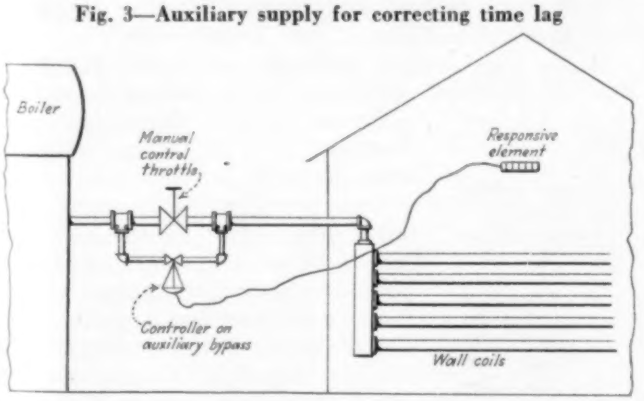
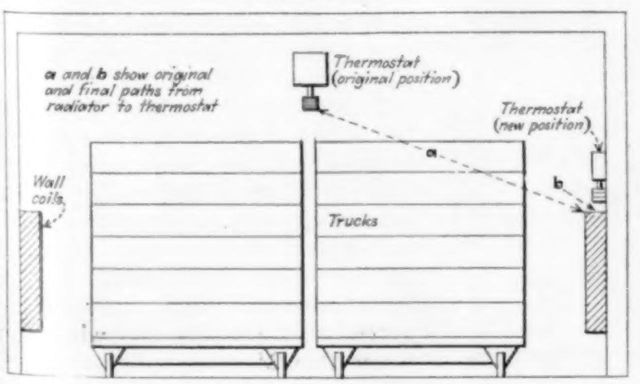


Fig. 4—Responsive-element relocation for correcting time lag



overcontrol. Both statements are self-evident and could almost be set up as rules. By following their implications, it is generally possible to devise a control system that will perform properly.

If, however, a time lag exists so that the action of the control source is not immediately followed (within a few seconds) by response in the apparatus, we have a most difficult situation which has been more or less insoluble. In fact, it is sometimes better to use hand control in such cases, with a continuously throttled source of supply. We will take up a practical solution of this problem later.

Now, having made our tests and plotted our curves, as in Fig. 2, we can inspect them and determine just what types of controllers will work properly.

1. If either rising or falling parts of the curves are rapid, any fast control can be used, with a narrow differential setting.
2. If both rising and falling parts are slow, any controller will do.
3. If a small time lag exists (1 minute or less), it is better to use slow, "throttling" control, or adopt some one of the suggestions later to be discussed under time-lag applications.
4. If a serious time lag exists (5 minutes or so) there is *no* perfect solution.

Time-Lag Applications

If time lag exists it is obvious that an automatic controller will follow the lead of its responsive element and (barring acts of God) will "over-correct." In other words, a rapid-action automatic control is precisely the worst that can be used on a time-lag system. In the case of a small time lag, it is often possible to use a slow-action controller. However, when the plotted curves show a very rapid change, once the time-lag period has elapsed, slow-action control will not solve the problem.

What is generally the simplest solution of time-lag problems is to use the arrangement shown in Fig. 3. This involves a fixed, steady source of supply which is never sufficient, unaided, to carry the apparatus up to the set point and, in addition, an auxiliary supply under regulation of a controller which can carry slightly beyond the set point when open. By adopting such means the problem reduces to that of a common one, and curves like Fig. 2*f* can be constructed.

A second solution of time-lag systems is to reduce or eliminate the time lag itself. This can occasionally be done by relocating the element of response, as shown in Fig. 4. This solution is the only completely satisfactory one, but it cannot always be accomplished.

Some instrument manufacturers make what they call "anticipatory" controllers for use in time-lag systems. These instruments are capable of complete shut off in cases of serious overheating but normally do not go to this extreme without several preliminary, fully automatic, anticipatory adjustments. These anticipatory features are obtainable in the electric types as well as in certain of the air-operated types.

In conclusion, the field of automatic control is a very fertile one for individual experiment and interesting study. This article has shown the fundamentals to consist of a body of scientific principles which should largely eliminate the unpredictable. Automatic control is rarely impossible; its success need never be left to chance.

LOOKING BACK AT

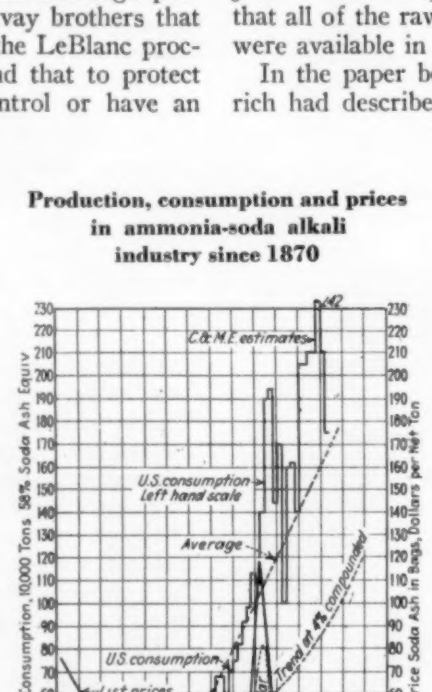
50 YEARS IN AMMONIA-SODA

BEFORE Ernest Solvay, in 1869, turned his attention to the ammonia-soda process for the manufacture of soda ash, the old LeBlanc process, which had been largely developed in England, was in universal use for alkali manufacture. It was complicated, the wastes were difficult to handle, the gases noxious, and the product of low purity. Also the consumption of fuel and other raw materials was excessive. Solvay early realized the potentialities and simplicity of a process that would utilize brine instead of solid salt, with ammonia as a vehicle, later to be recovered, and which required only moderate temperatures.

The ammonia-soda reaction had been discovered by others, probably as early as 1836, but the Solvay brothers did not learn of this until many years after they had an ammonia-soda plant in successful operation. They experimented for 20 years during which time they successively built four plants, each of different design, before they evolved the commercially successful design which was incorporated in the small plant at Coulliet, near Brussels, Belgium. The extraordinary success of this plant, with its concomitant low costs and high productivity, very early convinced the Solvay brothers that their process was destined to displace the LeBlanc process throughout the industrial world and that to protect their process, it was necessary to control or have an active interest in the establishment of ammonia-soda plants in other countries.

This policy eventually brought about the 26 soda-ash plants which utilized the Solvay process and in which the Solvay brothers maintained a financial interest. It should be pointed out, however, that this interest was not confined to the purely financial side, for among these plants there was a loose confederation within which there was a free and liberal interchange of all technical advances within the ammonia-soda industry. Ernest Solvay may be said to have been an internationalist in the sense that he encouraged this exchange of technical knowledge vital to the manufacturer of all the products of the Solvay process. He was, himself, the originator of many improvements in the process which he generously made available to all the other plants. His brother, Alfred, devoted himself to the purely commercial and financial aspects of the project; he arranged the contracts, devised the system of accounting and saw to the marketing of the products, and he also thoroughly followed his brother's altruistic policies.

Production, consumption and prices in ammonia-soda alkali industry since 1870



Soda-Ash Beginnings in America

As late as 1880 no soda ash was manufactured in the United States. What soda was consumed here was imported from England and sold for about $60 per ton. Herman Frasch, engineer for the Standard Oil Co., had built and attempted to operate a small soda plant at Bay City, Mich., but it was unsuccessful and had been dismantled. In 1879, William B. Cogswell, a mining and metallurgical engineer, who had come east from LaMotte, Mo., where he had been operating a mine for Rowland Hazard, attended a meeting of the American Institute of Mining Engineers in Philadelphia. There he heard a paper by Oswald I. Heinrich, a mining engineer of Drifton, Pa., which described the then new ammonia-soda process. (This interesting paper is in the *Transactions of the American Institute of Mining Engineers* for 1879.) Mr. Cogswell was struck by the fact that all of the raw materials needed for this new process were available in Central New York.

In the paper before the mining engineers, Mr. Heinrich had described and especially commended the small plant of a Mr. Gerstenhoefer in Hungary, and Mr. Cogswell, who went to Germany a little later to convalesce from an illness, commenced negotiations with Gerstenhoefer for a set of plans with the intention of building a plant in Syracuse. But before the contract was completed, Mr. Gerstenhoefer became seriously ill and the negotiations were dropped. Mr. Cogswell then learned from a German friend that the Solvays of Belgium had established a successful soda-ash plant and in all probability they would consent to establishing a plant in the United States.

It was difficult for Mr. Cogswell to get an appointment with the Solvays because their experiences with American promoters of the cow-hide boots, tobacco-chewing type had been rather unfortunate and they were wary of further association with "rugged Americanism." But they finally agreed to a meeting and when they found that Mr. Cogswell was a gen-

ALKALI INDUSTRY

By EDWARD N. TRUMP
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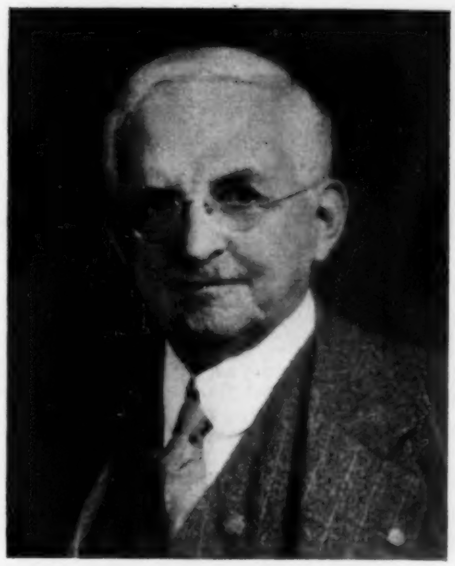


This month Mr. Trump completed his fiftieth year in the alkali industry. He joined the Solvay enterprise at Syracuse as assistant engineer on March 6, 1882, after a long and practical apprenticeship in the machinery and beet sugar industries. He rose to the position of vice-president and general manager before resigning in 1930 to organize his own company of consulting engineers. Of the many honors that have come to Mr. Trump in his long and active career he prizes most his 50-year badge in A.S.M.E. which he has served as vice-president and in many other capacities.

tleman, well-bred in continental standards of manners and an engineer of intelligence, they were more receptive. However, they were not ready to undertake the building of a plant in the United States for they were already occupied with the construction of plants at Dombasle, France, and, in connection with Brunner, Mond & Co., at Northwich, England.

For three months, Mr. Cogswell waited in Hanover for some word from the Solvays, and when he received no word, he again wrote them asking that they reconsider the matter. He was encouraged when he received a letter from them asking for references. He obtained letters from Andrew D. White, President of Cornell University and afterward Ambassador to Germany, Rowland Hazard, of Providence, R. I., a gentleman of wide European acquaintance, and Judge Charles Sedgwick of Syracuse. These letters evidently impressed the Solvays for they invited Mr. Cogswell to come to Brussels and commissioned him to investigate locations for a plant in the United States.

At that time large quantities of salt were being obtained in Syracuse from the natural brine of 75 per cent saturation, by solar evaporation and also by boiling it in cast-iron pots set over furnaces fired with culm coal from Pennsylvania. After Mr. Cogswell had made a study of the geological condition of the region around Syracuse, he became convinced that there was a large bed of rock salt near and since there was available plenty of good quality limestone in quarries, already opened, Mr. Cogswell decided that Syracuse was a fine location for an ammonia-soda plant. Rowland Hazard agreed to help him with the financing of a plant. Then, with the facts of their survey and an account of their financial resources, the two men went to Brussels and persuaded the Solvays to join them in founding the ammonia-soda industry in America. They agreed and the Solvay Process Co. was organized in September, 1881, with Rowland Hazard as president, William B. Cogswell as manager and engineer and O. V. Tracy, secretary and treasurer. One-third of the original capital was supplied by the Solvays and two-thirds was supplied by Hazard, Cogswell, and a small group of their friends in Syracuse.

A plant site was purchased in the fall of 1881 near Onondaga Lake adjoining the Erie Canal and situated between the Auburn branch and main line of the New York Central Railroad and close to the Delaware, Lackawanna and Western Railroad. This site had the advantages of good transportation facilities, a plentiful supply of cold water, good drainage and a large tract of lowland available for waste deposits.

The Solvays had agreed to supply the plans for the special apparatus and the general arrangement of the plant. After contracting for the chimney and the main building, Mr. Cogswell went back to Brussels to get these plans, taking with him Wm. L. Neill, the first employee of the Solvay Process Co., a chemist who knew French and German and who had been with him at Mine LaMotte in Missouri.

When Mr. Cogswell returned in March, 1882, he needed engineers and asked John E. Sweet, founder of the American Society of Mechanical Engineers and an instructor in engineering at Cornell University, to recommend an assistant engineer to him. Fortunately for me, I had been in Mr. Sweet's class at Cornell, and had kept in close touch with him after graduation. Mr. Sweet was good enough to recommend me to Mr. Cogswell and upon being engaged by him, I immediately began working on construction drawings, translating the metric dimensions of the Belgian drawings into English units and supervising the construction of the buildings and installation of the machinery. Many of the larger cast-iron rings used in the construction of distillation, absorption and precipitation towers were made in Belgium but the smaller iron castings were made in John E. Sweet's foundry, the Straight Line Engine Works of Syracuse, where also were built the driving engines. An unusually large gas compressor was required for the

precipitation and one was designed by Mr. Sweet and built by I. P. Morris, of Philadelphia.

As the plant neared completion, organization of an operating force was begun. Henry Cooper, of Philadelphia, and Nicholas Bodot, of Brooklyn, were sent to join William L. Neill at the Dombasle works of Solvay et Cie. to study the process. I joined them there during the lull in construction and for two months made a study of the plans which were in project and gained some knowledge of the piping and the operation of the machinery. On returning to Syracuse in January, 1883 the work of construction was pushed forward as rapidly as possible and the plant was completed and operations started in January, 1884.

The actual chemical reactions involved in the production of ammonia soda have not been changed since their conception by Ernest Solvay. However, the detailed design of each piece of apparatus has changed so radically that it is doubtful if any modern plant would be infringing upon the original patents of Ernest Solvay, even if they were in force today. These changes have all come about gradually; the mechanical perfection of the equipment used, and the present operating efficiency of the process were worked out step by step as the demands for changes became imperative. The accompanying drawing is a flow diagram of the process showing the principal equipment and connections of a modern ammonia-soda works. Because of the very liberal policy of the interchange of ideas already referred to, all of the Solvay plants cooperated toward this perfection and one could say that the engineering skill of the entire world was utilized in bringing each piece of apparatus used in the process to a state of efficiency and perfection that benefited the whole industry.

Wherein Byproduct Coke Develops

About 1895 the ammonia used in the process, and which had been furnished by the Illuminating Gas Co. of Syracuse and other cities, became difficult to obtain. Solvay et Cie. of Belgium had experienced the same trouble and had solved it by the invention of the byproduct coke oven designed by Louis Semet, who was the brother-in-law of Ernest Solvay. In order to meet our need for ammonia, the first Semet-Solvay coke oven plant of 12 ovens was built in Syracuse. The coke produced by the Syracuse ovens was used in the lime kilns, and the ammonia and coke oven gas were utilized in the process. The public need for coke and the increasing markets for coke-oven byproducts, led the Solvay Process Co. of Syracuse to enlarge its activities in this field. A subsidiary company called The Semet-Solvay Co. was formed and plants were built to supply coke for blast furnaces, foundries and domestic use; also benzol was recovered and sold to color works; and the illuminating gas from these ovens was sold to the public utilities and used by consumers.

The Solvay Process Co. was undergoing a rapid growth throughout this time and not only was the original plant at Syracuse increasing its capacity, but a second soda works and a large coke-oven plant were built in Detroit in 1898. Anticipating a normal growth with time, the engineers designed this plant to expand in a methodical fashion, and their forethought seems fully justified for the plant has grown to the place where it is second in size only to the Syracuse plant, which is the largest alkali plant in the United States and largest single ammonia-soda plant in the world. During the War the company also operated a plant at Hutchinson, Kansas, which had been acquired by purchase. It had originally been built to manufacture soda ash, but had been unsuccessful. When the Solvay Process Co. acquired it, it was partly remodeled and operated until after the War. There are large salt deposits in this vicinity, of course, but the distance from the limestone supply and the inefficiency of the equipment made operations too costly when compared with those at Detroit.

In 1917 the Solvay Process Co. joined with Brunner, Mond & Co., of England, the English associates of the Solvay system, to establish Brunner-Mond, Ltd., of Canada. A plant was designed by the Syracuse engineers and built at Amherstburg, Ontario, near the mouth of the Detroit River. The plant was located extremely advantageously, having limestone on the site of its buildings and salt within easy access. Later this property was acquired by the Solvay Process interests.

Technology Underlying Business Success

Any account of the spectacular progress of this industry in America would be incomplete without some analysis of the reasons which contributed to its success. It is the belief of the writer that no other chemical industry can exhibit a comparable technical and operating advance, nor such an extremely high production with resulting low costs. Of course, the low costs of production are also attributable to the technical skill, which, in the case of the Solvay process was contributed to by almost every industrial country in the world.

Some idea of the tremendous reduction in the price of soda ash can be had when one considers that in 1884 the soda ash imported from England sold for $60 a ton; when the Syracuse plant started producing, the importers dropped the price to $40 and at the end of the first year the Syracuse plant was able to manufacture at less than this price, and in the second year of its operation (1885) soda ash sold for $42 and the plant showed a profit. By the end of 1886, the plant, due to improvements in the equipment, had tripled the original rate of output From that time on, the machinery and the technique of operation were continuously improved and costs were lowered until just before the World War in 1914, when they were the lowest on record and soda ash sold for $20. Fig. 1 shows the list price, production and consumption in United States since 1870. These data give evidence of the benefits obtained from cooperation.

International Cooperation

The methods and procedures by which technical information was exchanged and put to use in all countries where the Solvays had interests, is of such a unique nature that a detailed explanation of it is justified. Every month each plant exhibited to each of the other plants, which gradually grew to 25 in number, its fundamental technical operating data for the preceding 30 days. The operating data to be interchanged between plants were carefully selected and agreed upon by the technical staffs of all the associated companies. The detail of the operating sheets once agreed upon could

not be changed except by a majority vote of the duly accredited technical representatives of the plants. The methods to be employed to obtain the data to be exhibited on the operation sheets were also carefully thought out and delineated. Thus, the technical staff of each plant had before it, at all times, the latest operating data from every other plant in the system. They knew the quantities of the raw material being used and the analyses of the products obtained; the temperatures, pressures and concentrations in the various apparatus. They knew the consumption of fuels, the volume of all the liquors, the efficiencies and losses.

A technician in the Detroit plant could discuss intelligently and correctly the results obtained at the Bereseniky plant in Russia and compare the results with his plant. Every man was on his toes to beat the results obtained at the other plants and to show his results on the sheets. A Technical Committee was formed in each country and an International Committee of the principal engineers and operators met in Brussels at yearly intervals to discuss interesting problems. The principal engineers were encouraged to visit the various plants and changes in design of apparatus at Brussels or any other plant were made known to all other plants. New devices were developed in those plants which achieved nearer to the goal of perfection. The results of research at the main laboratory in Brussels or any laboratory of the system were available to any member of the system.

The main office at Solvay et Cie. in Brussels acted as a central clearing house for the system, and at regular intervals published and distributed a technical review.

Because visiting between plants was encouraged, the American staff knew intimately the principal men in Brussels and in the other plants of the system. They profited greatly from these contacts and the varied points of view which these associations were bound to develop. The intelligence and broad vision of the foreign associates were held in high esteem and undoubtedly they, on their part, gained something from their contact with the American engineering mind. This combination produced many inventions and improvements which were used many years before they were adopted by other industries.

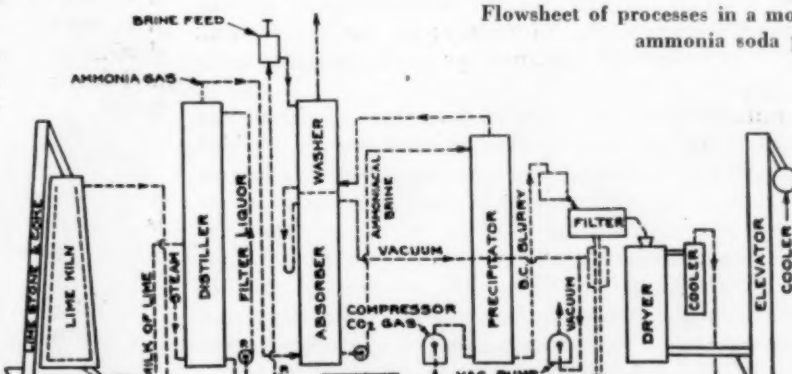
Pioneering in Human Relations

The writer would be overlooking one of the principal contributions of the Solvay association to the industrial system were he to fail to speak of the relation between employers and employees and the welfare work carried on by the various member firms and companies. Ernest and Alfred Solvay, apart from their technical abilities, were men of rare insight into the problems of the vast industrial systems of Europe and America. Through their writings, their special research institute, through discourse and through the conduct of their business, they made notable contributions to the science of sociology.

They fully realized that the *raison d'etre* of industry is to contribute to man's comfort and happiness, that man must be the master of industry, not industry the master of man, that no industry should demand the sacrifice of its workers in order to maintain it, and that an industry that did demand this, was unworthy of its existence. In their sociological ideas the Solvays were singularly ahead of their time, and they were neither afraid nor did they lack the philanthropy to put their ideas into effect in their own companies. They established a system of profit sharing, of care for the sick and injured among their employees, and of old-age pensions. They established welfare and recreational centers at their various plants. In all their pioneer work in the field of human relations they were ably followed by the Brunners and Monds of England and by the Hazards and Cogswells of Syracuse. It is the belief of the writer that the Solvay Process Co. was one of the first, if not the first, among the great American industries to reduce shift-work from 12 hr. to 8 and to create sick and accident benefit associations and old-age pensions.

In 1921 the Solvay Process Co. together with its subsidiaries, the Semet-Solvay Co. and the Atmospheric Nitrogen Corp., were combined with General Chemical Co., Barrett Manufacturing Co., and National Aniline and Chemical Co. to form the Allied Chemical and Dye Corp. By this combination, the Solvays, the Hazard and Cogswell families surrendered the controlling interest that they had up to that time. The management of Allied Chemical and Dye Corp. was apparently unwilling to maintain the technical relation with Solvay et Cie. and Brunner-Mond & Co., which had existed for 40 years, so all exchange of information was quickly suspended.

It is the personal belief of the writer that American industry has suffered a great loss by this action. However, the Solvay Process Co., since its absorption in Allied Chemical and Dye Corp. has contributed to the alkali business in the United States a number of its best technicians. This contribution has been of considerable profit to the other alkali companies and they should be duly cognizant thereof. It is to be regretted, however, that many of the features of its profit sharing plans and much of its pension system and other welfare work have been discontinued. Nevertheless, the contributions it made in its youth to American industrialism may well warrant our overlooking the latter day trends, which perhaps are of the sort so often the concomitant of advancing years.



Flowsheet of processes in a modern ammonia soda plant

Making Radiographic Inspections

OF

CHEMICAL

EQUIPMENT

By HERBERT R. ISENBURGER

Secretary
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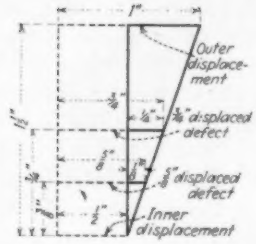


Fig. 1a—At Left: Double exposure exograph showing displacement of lead surface markers and of defects; by determining defect displacement relative to displacement of surface markers, the location of defects can be calculated by the method shown above in Fig. 1b

IN RADIOGRAPHIC EXAMINATION shadow pictures are obtained showing the interior condition of the object under investigation. These pictures are made by means of a penetrating radiation of either X-rays, produced electrically by an X-ray tube, or by gamma-rays, which are of shorter wave length than X-rays* and are obtained from radium, mesothorium, or their emanations. X-ray pictures are known as "exographs" as distinguished from "radiographs" made by means of gamma-rays. As with ordinary photographs, darker regions on the negative or lighter regions on the print mean that more rays have passed through the object at that point, indicating that the object is more transparent at these points. Hence cavities in a weld will show up on the print as lighter spots, whereas denser metal will appear as darker regions.

Absorption of the rays grows with the atomic weight of the material examined. When X-rays are used, absorption is almost proportional to the third power of the atomic number of the element. For ready reference some atomic numbers and weights are given in Table I. On account of its high atomic weight, lead is used to protect the operator, since sufficient thicknesses of lead will absorb the X-rays completely; on the other hand, about 1 per cent of gamma-rays will penetrate even through 2 in. of lead.

In radiographic inspection of pressure vessels we are primarily concerned with the examination of welded seams, although riveted vessels have been examined successfully. At the mention of radiographic weld inspection, one automatically thinks of X-ray examination. The author has discussed at length (Trans. A.S.S.T., 1932, pp. 752-67) why gamma-rays are not useful for weld inspection below 3-in. plate stock and has demonstrated conclusively that even on thicknesses up to 5 in. of steel, X-ray inspection is more economical, unless girth seams are to be inspected. Pressure vessels seldom exceed a 5-in. wall thickness and are mostly below 3 in. We do not, therefore, have to consider gamma-rays in our further discussion of the subject, particularly since the A.S.M.E. Boiler Code requirements state that a 2 per cent marker must record properly on the negative, and gamma-rays will not show up such a marker below 5 in. of steel.

Pressure vessels for the chemical industry have to be especially safeguarded against corrosion. The thinner the plate stock the more important is the absolute soundness of all welded seams, especially toward the inner surface of the vessel. If serious defects show up in an exograph the weld usually can be repaired. In order to determine from which side the weld metal should be chipped out, we have developed a double-exposure technique whereby two pictures are made on one and the same film (*Amer. Mach.,* **76,** 1932, p. 133). Between exposures the tube is shifted a certain known distance. Thus we obtain two pictures on one film of the same portion of the seam. Before making this double exposure, we place lead markers on the outer and inner surfaces of the vessel, close to the defective spots. Such a double-exposure exograph of a weld is shown in Fig. 1*a*. The outside marker is a lead square and the inner one a narrow strip of lead. Careful measurement shows that the displacement on the outside is just 1 in. whereas the inside marker is displaced only ½ in. A comparison of the relative displacements of

Table I—Atomic Numbers and Weights of Elements

Element	Atomic Number	Atomic Weight	Element	Atomic Number	Atomic Weight
N	7	14.00	Cu	29	63.57
O	8	16.00	Zn	30	65.38
Mg	12	24.32	Sn	50	118.70
Al	13	26.97	W	74	184.00
Fe	26	55.84	Pb	82	207.20
Ni	28	58.69	...	..	......

*The average wave length of X-rays is about 1/10,000 that of ordinary light, and 1,200,000 volts would be required to obtain X-rays with a wave length equal to that of gamma-rays.

the various defects in the weld metal shows them all to be between $\frac{3}{4}$ in. and $\frac{5}{8}$ in., indicating that the defects occur in the inner half of the weld.

It is now a simple matter to calculate how far from the inner surface a $\frac{5}{8}$-in. displaced defect lies. The thickness of this particular weld is $1\frac{1}{2}$ in. Hence, the various displacements may be represented by a right triangle as in Fig. 1*b*, with an altitude of $1\frac{1}{2}$ in. and a base of $\frac{1}{2}$ in. (the difference between the outer and inner displacements). Then by simple proportion the altitude of a similar triangle, with a base equal to the increased displacement of the defect over that of the inner marker, can be calculated. For the $\frac{5}{8}$-in. displaced defect, this is $\frac{3}{8}$ in., meaning that the defect is $\frac{3}{8}$ in., from the inner surface of the vessel. Similarly, a defect of $\frac{3}{4}$-in. displacement lies at the median line of the weld.

In this way defects can be localized more easily, quickly and economically than by the stereoscopic method which also necessitates the use of expensive equipment. Besides, we are able to observe the location of the defects about 10 minutes after the picture is made, while the negative is still in the fixing bath. Obviously, this speeds up production considerably. When using the stereoscopic method we have to wait until the two negatives are completely dry and then depend on the judgment of the human eye.

Much valuable information can be secured by comparing the outside conditions of a weld with the exograph. For instance, a four-layer, double-V weld in $\frac{3}{4}$-in. plate, machine beveled at 45 deg., is illustrated in Fig. 2. As is evident from Figs. 2*a* and *b*, the bead on one side of the plate is much more uniform than on the other. The latter, due to its irregularities, has the greater influence on the resulting X-ray picture. Fig. 2*c* shows a print of a film exograph through this weld and 2*d* a paper negative, both of which indicate considerable porosity. The last picture, 2*e*, is a longitudinal section of the left-hand end of the weld. The section is located so that but one hole, *F*, on the exograph is in view. The smaller holes on the macrograph are practically invisible on both the film print and the paper negative (of the latter more will be said later). These holes can, however, be observed in the film negative. The section is magnified about three times and shows a portion where the reinforcement bead contains an abrupt offset. In the X-ray this irregularity is about $\frac{3}{8}$ in. to the left of hole, *F*. At this location, electrodes were changed both at the top and bottom. This is indicated on the macrograph by the refined band through the bead and the offset immediately following. The top and bottom beads were laid in opposite directions.

Fig. 2—Internal and External Evidence of a Double-V Weld

***a* and *b*, weld surfaces above and below; *c* and *d*, respectively film print and paper negative of the weld; *e*, cross-section of the weld, magnified about 3×; point *F* represents one defect**

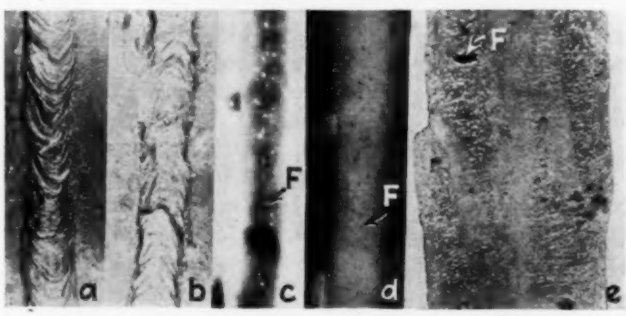
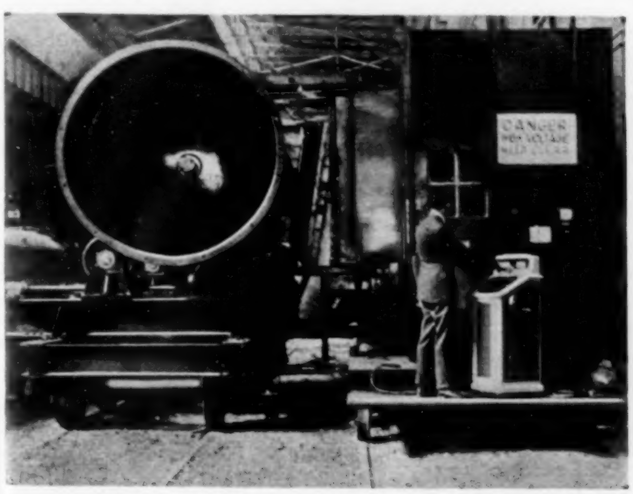


Fig. 3—X-ray equipment in the plant of the Sun Shipbuilding Co.



The various defects found in welds have been discussed by the author elsewhere (*Mech. Eng.*, **53**, 1931, pp. 729-35) and need not be recapitulated here. It is worth while, however, to note what sort of weld can be and is being made with proper welding procedure. In a typical exograph of a sound weld through $2\frac{1}{2}$ in. of steel (not shown here) the weld itself is not distinguishable from the plate; only by the location of the lead reference markers can the weld zone be determined when the beads have been planed off. No manufacturer need fear to prove this to his customer who will be much better satisfied when he has seen such convincing evidence of the actual soundness of the material he expects to install in his plant.

X-Ray Equipment

A typical X-ray installation which we recently made in the plant of the Sun Shipbuilding Co., at Chester, Pa., appears in Fig. 3. The 200-kilovolt X-ray generator and tube are mounted on a movable car parallel to the pressure vessel, which is set up on a second track. Flexibility and convenience have been secured by a coordinated system of supporting and shifting the vessel to be X-rayed and of supporting and shifting the X-ray tube. This machine can penetrate 3 in. of steel in a 30-minute exposure. On account of its bulky design it is not suitable for the field work required in the chemical industry. Such field inspection of welds is rather important after the vessel has been in service for some time. It is not unusual for towers surrounded by structural framwork to be X-rayed. For this purpose it is necessary to have a compact and rigidly build outfit capable of penetrating 3 in. of steel in a 1-minute exposure. Our company has just completed the development of such equipment. The outfit is extremely compact and is shock- and X-ray-proof, with all parts immersed in oil, including the X-ray tube.

A unit of this type for continuous operation at 300,000 volts is only about 6 ft. long and less than 2 ft. wide by 3 ft. high. It can be operated in any position.

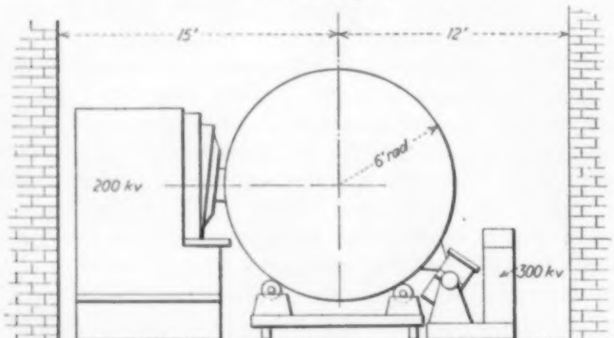
Slung from a derrick it will serve for vertical tower inspection; mounted on a trunnion support it can be used in the boiler shop; set up on a little trailer it can readily be shipped from one factory to another. It may be interesting to visualize the actual size of this powerful unit by comparing it with the regular size equipment now in use. Fig. 4 indicates the Sun installation at the left and the new St. John unit at the right, set up on a 12-ft. diameter drum. The great difference in size is obvious. Considering that the new outfit is portable, that it is only one-quarter the size of the old and yet much more powerful, that it is contained in a single tank and is of much sounder electrical construction, we feel that it marks a very important advance.

Cost of X-Ray Examination

Performance of the new machine is noteworthy since the operating cost on 2-in. material, for instance, is less than that with the 200-kilovolt equipment. Fig. 5 gives a number of curves which show the cost of examining 1-ft. of weld, with various kinds of X-ray equipment and with radium. It is to be noted that these costs are averages of figures for longitudinal and girth seams and that they do not include the costs of setting up and handling apparatus to be X-rayed. It is evident, for example, that a 120-kilovolt outfit should only be used on thin material, preferably not thicker than $1\frac{1}{16}$ in. of steel. The 200-kilovolt machine is economical to use up to $2\frac{1}{4}$ in. of steel, although the 300-kilovolt machine is cheaper to operate at 2 in. Above $3\frac{1}{2}$ in. the cost for radiographic inspections rises considerably. The cost for a girth seam with a 4-ft. outside diameter and 4-in. plate stock would be \$15 by means of the new 300-kilovolt X-ray equipment, and \$25 when using 500 mg. of radium; but the time required would be about 7 hours in the case of X-rays and only 5 hours when radium is used. An increase of 1 in. in plate thickness would make the cost of X-ray inspection almost three times as much as that when the radium is employed, which then would amount to \$45 and would take a 12-hour exposure, whereas X-rays would take about 55 hours. Here, gamma-ray inspection is more economical. On longitudinal seams, however, gamma-ray inspection is higher on 5-in. plate, although it is faster than X-rays.

As an indication of the variation of cost with thickness let us consider the complete X-ray inspection of all welded seams in a pressure vessel of 4 ft. outside

Fig. 4—Comparison of new 300-kv. equipment with that of Fig. 3



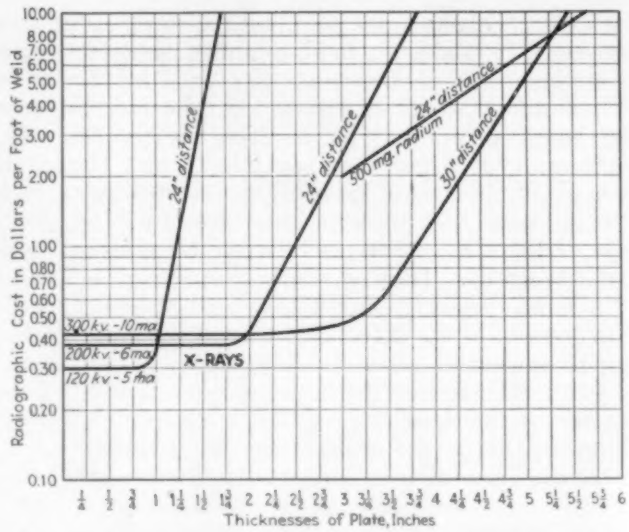


Fig. 5—Average cost per foot of radiographic inspection by various X-ray equipment and radium

Table II—Cost of X-Raying 40x4-ft. Vessels

Plate Thickness, Inches	Radiographic Equipment	Cost of Complete Examination, Dollars
1	120 kv. X-ray	32.70
2	300 kv. X-ray	38.20
2	200 kv. X-ray	40.00 (about)
3	300 kv. X-ray	42.00
4	300 kv. X-ray	109.60
4	500 mg. radium	330.00 (about)

diameter, about 40 ft. long including heads, with three 10-ft. longitudinal seams and four girth seams. For plate thicknesses ranging from 1 to 4 in. the comparative costs, including setting up and handling, are given in Table II. The cost for the 1-in. vessel could be brought down to less than \$25 by using photographic paper instead of film. Such an exograph on paper was shown in Fig. *2d*. This new medium for recording X-ray evidence costs about one-third as much as film. It does not give as fine contrast as film, but the results are about the same as those in a print from a film negative. The exposure time is the same for 1 in. and less; above that thickness we have not yet collected reliable data. Since the paper is coated on one side only, we can use a single intensifying screen instead of a pair as is necessary with the doubly coated film.

Broader Possibilities for X-Raying

This new photographic paper offers promising possibilities for the wider application of radiographic inspection in chemical industries. The new portable 300-kilovolt unit makes field inspection possible and permits the examination of 3-in. and even 4-in. thicknesses within a short exposure time. Both innovations tend to bring the operating cost down considerably, thus making radiographic inspection more economical, both for welded pressure vessels, such as towers and digestors, and for castings, forgings, and a great many other parts used in chemical equipment. These developments, it is to be hoped, will be added inducements toward a wider application of radiography. The radiologist offers his methods as new tools for the chemical engineer; to the latter is left their use in assuring sounder apparatus and increased safety.

Cost Accounting and the Chemical Engineer—II

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PRESENTATION of data reflecting and explaining past events has been the objective of accountants. A change is taking place in the direction of statements comparing current expenditures with "standard," in so far as they refer to items influenced by the individual's judgment and action. Systematic methods of analysis have been devised which automatically indicate underlying causes of economic variations and increase the probability of prompt and beneficial executive action. The first article of this series dealt with the various systems of computing cost and the principal factors to be considered. In the present installment, by way of illustration, the principles and mechanism involved in these systems are applied to the operating and sales statistics of an imaginary petroleum refinery, with the results for the month of January set forth in eight tables.

The plant is expected to "crack" 24,400 bbl. of crude oil per month, and this single process is assumed to produce 12,000 bbl. of marketable gasoline, and tar and gas equivalent to 12,200 bbl. of bunker fuel oil. A monthly profit of $7,130 is anticipated from the standard figures of cost and sales returns summarized in Table V.

Table VIII, the key statement, comparing the actual with the standard profit, shows failure to meet expectations to the extent of $1,305, and the extent to which the three department heads contributed to this result.

The manufacturing manager appears superficially in a favorable light, since by skillful manipulation of his

Table I—Standard Costs Varying With Throughput Rate

Item	Standard Unit Quantity/Bbl. Crude Processed	Standard Unit Price	Standard Unit Cost/Bbl. Crude Processed
Symbol	qs	ps	$cs = qs \times ps$
Crude Oil	1.000 bbl.	$1.15/bbl.	$1.150
Labor	0.075 man-hr.	0.80/man-hr.	0.060
Steam	30.000 lb.	0.50/M lb.	0.015
Other manufacturing expense*	0.025 still-hr.	8.00/still-hr.	0.200
Total standard cost varying with throughput			$1.425

* It will be understood that the term in Tables I, III, etc.—"Other manufacturing expense"—is used for the sake of simplicity to cover the usual individual items of cost, here assumed all to vary directly with rate of throughput.

Table II—Standard Costs Varying Independent of Throughput Rate

(Unit costs are based upon a standard (30.5 day) month)

$$\text{Standard month} = \frac{365}{12} = 30.5 \text{ days}$$

Item	Standard Total Quantity	Standard Unit Price	Standard Total Cost	Standard Throughput	Standard Unit Cost/Bbl. Crude Processed
Symbol	Qs	ps	$Cs = Qs \times ps$	Ts	$cs = \frac{Cs}{Ts}$
Supervision	1 man	$350/month	$350	24,400 bbl.	$0.01435
Steam	1000 M lb.	0.50/M lb.	500	24,400 bbl.	0.02050
Depreciation	1 still	3000/month	3000	24,400 bbl.	0.12295
Total cost varying independent of throughput rate					$0.1578
Total cost varying with throughput rate (from Table I)					1.4250
Total standard unit cost					$1.5828

Standard throughput for a standard month = Ts = 24,400 bbl. crude oil

$$\text{Standard throughput for January} = Tc = 24{,}400 \times \frac{31}{30.5} = 24{,}800 \text{ bbl. crude oil}$$

Explanation of the Problem, the Terms and the Tables

To facilitate ready understanding of the method of deriving the analytical formulae, the following typical examples are given.

For instance, take the item of labor in Table IV. If from the actual man-hours (Qa) the standard man-hours $(Ta \times qs)$ are deducted, and the remainder is multiplied by the standard price per man-hour (ps), the net loss due to the use of greater than standard man-hours is obtained separately and distinct from the effect of any change in unit price.

Similarly, the effect of any change in unit price is separated by multiplying the difference between standard unit price (ps) and actual unit price (pa) by the actual man-hours consumed (Qa).

Thus, the two equations necessary to resolve the total difference between actual and standard cost of labor into its two component factors, change in quantity consumed and change in unit price paid, are formulated once and for all for the use by the clerical force, as follows:

$$\text{Quantity Variation} = (Ta \times qs - Qa)ps$$
$$\text{Price Variation} = (ps - pa)Qa$$

Tables I, II and III contain standard and actual plant data, used to construct—

Table IV, which is an analysis of variations in manufacturing cost.

Tables V and VI contain standard and actual sales data used to construct—

Table VII, which is an analysis of variations in sales return.

Table VIII is the final analysis of profit variation classified by executive responsibility.

The following list will serve as a ready reference for the meaning of the symbols used in the various tables.

LEGEND

Ca = Actual total cost
Cs = Standard total cost
ca = Actual unit cost
cs = Standard unit cost
pa = Actual unit price
ps = Standard unit price
Qa = Actual total quantity
Qs = Standard total quantity
qa = Actual unit quantity
qs = Standard unit quantity
ra = Actual unit market realization value
ri = Unit inventory value
rs = Standard unit market realization value
Ta = Actual throughput for actual month
Tc = Standard throughput for actual month
Ts = Standard throughput for standard month
Vi = Volume (bbl.) of product in inventory
Vs = Volume (bbl.) of product actually sold
Ya = Actual yield (per cent)
Ys = Standard yield (per cent)

The second of two articles, modified slightly from the paper presented by the authors under the same title before the American Institute of Chemical Engineers at Washington, Dec. 8, 1932.

Table IV—Comparison of Standard With Actual Manufacturing Cost for January

Item	Standard Total Cost for January = Actual Throughput @ Standard Unit Cost	Actual Total Cost for January = Actual Throughput @ Actual Unit Cost	Total Variation Actual From Standard + = Saving — = Loss	Variation Due to Quantities Consumed per Unit of Throughput	Variation Due to Change in Quantities Consumed per Unit of Time	Variation Due to Unit Price Paid for Quantity Consumed	Variation Due to Change in Throughput Rate (Crude Capacity)	Variation Due to January Being a 31-Day Month
Symbol	$Ta \times cs$	$Ta \times ca$	$(Ta \times cs) - (Ta \times ca)$	$(Ta \times qs - Qa)ps$	$(Qs - Qa)ps$	$(ps - pa)Qa$	$(Ta - Tc)cs$	$(Tc - Ts)cs$
Costs varying with throughput rate:								
Crude oil	$29,900	$28,600	+ 1,300	×	×	+ 1,300	×	×
Labor	1,560	1,575	— 15	— 120	×	+ 105	×	×
Steam	390	480	— 90	— 10	×	— 80	×	×
Other mfg. exp.	5,200	6,300	— 1,100	— 400	×	— 700	×	×
Total	$37,050	$36,955	+ 95	— 530	×	+ 625	×	×
Costs independent of throughput rate:								
Supervision	$373	$350	+ 23	×	×	×	+ 17	+ 6
Steam	533	780	— 247	×	— 150	— 130	+ 25	+ 8
Depreciation	3,197	3,000	+ 197	×	×	×	+ 148	+ 49
Total	$4,103	$4,130	— 27	×	— 150	— 130	+ 190	+ 63
Grand total manufacturing expense:	$41,153	$41,085	+ 68	— 530	— 150	+ 495	+ 190	+ 63

Table III—Actual Plant Costs for January

Item	Actual Total Quantity	Actual Unit Price	Actual Total Cost
Symbol	Qa	$pa = \frac{Ca}{Qa}$ (Calculated)	$Ca = Ta \times ca$
Costs varying directly with throughput rate:			
Crude oil	26,000 bbl.	$1.10/bbl.	$28,600
Labor	2,100 man-hr.	0.75/man-hr.	1,575
Steam	800,000 lb.	0.60/M lb.	480
Other manufacturing exp.	700 still-hr.	9.00/still-hr.	6,300
Total actual cost varying directly with throughput rate			$36,955
Costs varying independent of throughput rate:			
Supervision	1 man	$350/month	$350
Steam	1,300 M lb.	0.60/M lb.	780
Depreciation	1 still	3000/month	3,000
Total actual costs varying independent of throughput rate			$4,130
Total actual cost			$41,085

Actual crude throughput in January = Ta = 26,000 bbl.

Table V—Standard Realization and Profit on Standard Products in a Standard Month (30.5 Days)

(After deducting selling and administrative expense)

Item	Production Volume	Standard Unit Realization or Standard Unit Cost	Standard Total Realization or Standard Total Cost
Symbol	$Ts \times Ys$	rs or cs	$Ts \times Ys \times rs$ or $Ts \times cs$
Realization from sales:			
Gasoline (yield = Ys = 12,200/24,400 = 50%)	12,200 bbl.	$3.00/bbl.	$36,600
Fuel oil, etc. (yield = Ys = 12,200/24,400 = 50%)	12,200 bbl.	.75/bbl.	9,150
Total all products	Ts = 24,400 bbl.	×	$45,750
Deduct estimated (standard) mfg. cost	24,400 bbl.	1.5828 (From Table II)	$38,620
Anticipated profit for std. month (30.5 days)			$7,130

apparatus he has obtained more high-priced gasoline and less low-priced fuel from the crude oil than was expected, thereby making possible an increase in profit, of $1,125 had the entire production been sold; he has been able to process crude oil in excess of the standard quantity which should have netted an additional $467, but his operations have been more costly than standard to the tune of $427, leaving him with a net credit of $1,165.

The sales manager failed not only to realize the expected market values, which cost the company $900, but he also failed to meet his estimate of total sales, so that goods have been held in inventory at cost prices, which,

Table VI—Actual Realization on Actual Products in January

(After deducting selling and administrative expense)

Item	Production Volume	Actual Unit Realization = ra or Inventory Value = ri	Actual Total Realization
Symbol	$Ta \times Ya$	ra or ri	$Ta \times Ya \times ra$ or $Ta \times Ya \times ri$
Gasoline:			
Sold	Vs = 10,000 bbl.	$2.85/bbl.	$28,500
Inventory change	Vi = + 3,500 bbl.	2.42/bbl.	8,470
Total gasoline production—bbl. (Yield = Ya = 13,500/26,000 = 51.92%)	13,500 bbl.	×	$36,970
Fuel oil:			
Sold	Vs = 12,000 bbl.	$0.80/bbl.	$9,600
Inventory change	Vi = + 500 bbl.	.68 bbl.	340
Total fuel oil production—bbl. (Yield = Ya = 12,500/26,000 = 48.08%)	12,500 bbl.	×	$9,940
Total all products	Ta = 26,000 bbl.	×	$46,910

Table VII—Variations of Actual Sales Realizations From Standard

Item	Standard Return = Standard Throughput Rate at Standard Yield Ratio, Valued at Standard Market Price	Actual Return = Actual Throughput Rate at Actual Yield Ratio, Valued at Actual Market Price	Total Variation Standard From Actual + = Saving — = Loss	Variation Due to Change in Yield Ratio	Variation Due to Change in Throughput Rate	Variation Due to Change in Market Price of Goods Actually Sold	Variation Due to Selling More or Less Than Actual Production (Inventory Change)
Symbol	$Ts \times Ys \times rs$	$Ta \times Ya \times ra$ or $Ta \times Ya \times ri$	Column No. 1 minus Column No. 2	$Ta\,(Ya - Ys)\,rs$	$(Ta - Ts)\,Ys \times rs$	$(ra - rs)\,Vs$	$(rs - ri)\,Vi$
Gasoline:							
Sold	$36,600	$28,500	—8,100	×	×	—1,500	×
Inventory change	×	+8,470	+8,470	×	×	×	×
Total gasoline	$36,600	$37,970	+ 370	+1,500	+2,400	—1,500	—2,030
Fuel oil:							
Sold	$9,150	$9,600	+ 450	×	×	+ 600	×
Inventory change	×	+ 340	+ 340	×	×	×	×
Total fuel oil	$9,150	$9,940	+ 790	— 375	+ 600	+ 600	— 35
Total all products	$45,750	$46,910	+1,160	+1,125	+3,000	— 900	—2,065

Table VIII—Analysis of Profit After Deducting Selling and Administrative Expense

	Anticipated for Standard Month	Actual for January	Variation + = Saving — = Loss
Total realization from sales	$45,750	$46,910	
Deduct total manufacturing cost	38,620	41,085	
Profit	$7,130	$5,825	—1,305

The reasons for the company's failure to realize the anticipated profit by $1,305 are as follows:

		Dollars:
Manufacturing Manager's Responsibility:		
Improvement in gasoline — fuel oil yield ratio		+1,125
Standard market realization on products resulting from increased crude capacity	+3,000	
Deduct cost of increased crude capacity at standard unit cost ($41,153 — 38,620)	—(+2,533)	
Net increase in profit at standard values due to increased crude capacity		+ 467
Manufacturing savings and losses over standard:		
Loss due to increased quantities consumed	— 680	
Saving due to calendar variation (Jan. = 31 days)	+ 63	
Saving (over standard) due to increased crude capacity	+ 190	— 427
Total manufacturing responsibility		+1,165
Purchasing Agent's Responsibility:		
Saving due to lower prices paid for labor, materials and supplies		+ 495
Sales Manager's Responsibility:		
Loss due to lower market price on goods actually sold		— 900
Loss due to not selling entire production (inventory change)		—2,065
Total sales responsibility		—2,965
Total Loss in Profit — All Responsibilities Combined		—1,305

had they been sold, would have shown an additional profit of $2,065; the statement shows a total loss charged against him of $2,965.

The analysis points directly to low sales volume as the most important cause of failure to meet expectations. Inquiry brings out the following facts: The sales manager based his sales budget on the manufacturing manager's estimate of production, expressing at the same time his disappointment that the plant could not produce more. The plant therefore, assuming a ready market, bent its energies to increase throughput, but failed to inform the sales department of its success. The sales manager, faced with falling market prices, and assuming that his supply was limited, attempted to hold his prices above the market level, succeeded in obtaining $2.85 per barrel for his gasoline as against an anticipated $3, but could have sold the entire output at $2.80. Had he done so an additional profit of $830 would have been realized. The situation clearly calls for greater cooperation between sales and manufacturing departments, and the latter must share the blame, and assist in correcting the fault.

The falling market is beyond company control and the condition can only be offset by increased production and decreased manufacturing costs This directs attention to the analysis of manufacturing costs shown in Table IV. Examination of these figures somewhat removes the manufacturing manager's glow of pride, as his economies are largely due to the good fortune of decreased unit costs of raw material, supplies and labor; he actually has used excess steam and other commodities, with a value at standard prices of $680 per month. Being urged to greater effort in that direction he turns to his subordinates and requires from them explanation and, where possible, correction of their excess expenditures.

Sufficient has been said to show the usefulness of statements of this kind; the purchasing agent may therefore be commended with no note of criticism for his contribution of $495 in the direction of success.

It will be noted that all computations required for this analysis are made by substituting actual figures for the symbols in the equations given in the column headings. These equations are formulated once for all by the expert accountant, and their solution is a mechanical operation requiring no reasoning on the part of the clerk preparing the statements.

Coating and Coloring Aluminum By Alumilite Process

COATING of aluminum by the Alumilite process of Aluminum Colors, Inc., and its coloring, sealing and other treatment, were described in the Feb. 1 issue of *American Machinist,* in an article by H. Bengston and R. E. Pettit. The Alumilite process produces an anodic oxide film of considerable corrosion resistance and great hardness and abrasion resistance. After cleaning and rinsing, the articles to be coated are suspended as the anode in a lead tank where the type of bath used depends on the results desired. Where particularly good corrosion resistance is to be produced the "A" bath is employed with an operating voltage of 12 to 15 volts and a current density of 12 to 14 amp. per sq.ft. For a flexible coating to permit the subsequent forming of the metal, the "B" bath is preferred, with a current density of 8 to 10 amp. In either case, temperatures of the order of 70 to 90 deg. F. are used. Baths consist of various concentrations of sulphuric acid, together with suitable organic or inorganic inhibitors or modifiers.

Although the development of the process is said to have been a long and painstaking task, its application is described as fairly simple, requiring no technical knowledge on the part of the operators. To produce a lustrous finish, the base metal must be equally well finished. During oxidation, the surface becomes somewhat etched, which may show up defects in the original metal. When the coated article is to have a lustrous finish, it is necessary to polish the resulting matte finish.

Treatment of coated articles varies considerably. They may be left in the plain, oxidized condition, or they may be colored with organic or inorganic colors, oiled, sealed, waxed, lacquered, etc. The coloring, briefly, consists in the immersion of articles, after oxidation, in specially selected aniline dye baths. For colors that must be commercially sunfast, a process of deposition of inorganic pigments within the pores of the coating may be employed. To prevent further absorption and materially to increase the corrosion resistance, a final sealing process has been developed for use on both colored and uncolored articles.

Coatings may be applied both to aluminum and to its alloys such as 2S, 3S and silicon alloys such as No. 43. Corrosion resistance of the coatings varies similarly to the resistance of the original metal, but is said to be much better. Complete information on the corrosion-resisting properties is not yet available, but it is known that alkalis and mineral acids attack the surface with varying degrees of rapidity, while neutral salt solutions do not attack it. The high abrasion resistance, already noted, is explained by the fact that the coating is substantially Al_2O_3, more or less hydrated and containing more or less sulphate. The oxide, itself, has a hardness of 9 on Moh's scale.

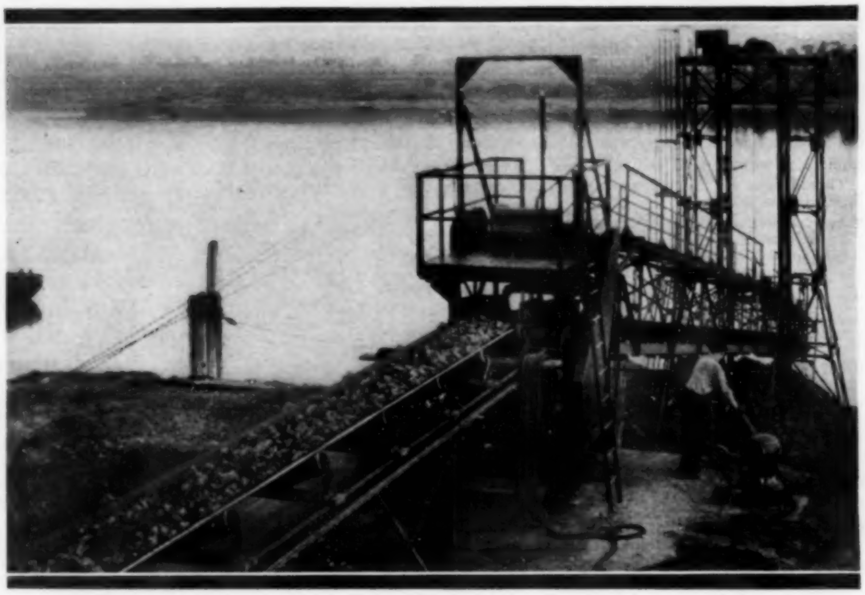


Fig. 1—At Portsmouth loading station coke from plant cars is dumped into a hopper to which is attached a reciprocating plate feeder which delivers 100 tons of coke per hour to a belt conveyor. At a point under the hopper the belt conveyor receives its load from the feeder. This conveyor extends horizontally through a tunnel under the yard tracks to the declivity of the river bank. It then becomes a hinged boom reaching out to low water anchorage of barges in the harbor.

CONVEYING SYSTEMS SIMPLIFY

● AT Portsmouth, on the Ohio side of the Ohio River, the Wheeling Steel Corp. produces coke. At Ashland, about 35 miles up the river on the Kentucky side, is the American Rolling Mill Co's. plant, a consumer of coke. The river connecting producer and consumer provides a dependable and comparatively inexpensive means of transporting coke produced in Portsmouth to the blast furnaces in Ashland.

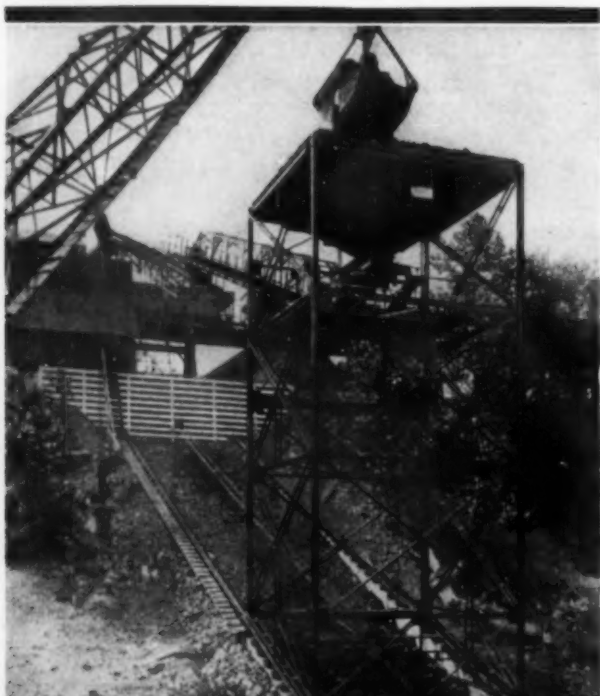


Fig. 4—The hopper is in top of a towerlike structure that is portable on a track running at an angle of 20 deg. from the water's edge up to the declivity of the river bank. Portability is necessary to accommodate varying water levels. The tower is the lower support of a belt conveyor that moves bodily with the hopper tower and discharges to a second and stationary conveyor which it telescopes as the tower goes up the incline.

Fig. 3—In nine hours after leaving the Portsmouth terminal with two barges of coke, we land on the opposite side of the river at Ashland where the unloading process begins. The coke is taken from the barge by means of a clam shell bucket and swinging boom mounted on a floating wharf. It is delivered into the Jeffrey hopper and conveyor unit.

Fig. 2—Discharge end of single belt conveyor leading from the hopper feeder out over the adjustable boom and discharging under controlled conditions directly into barges. The tower structure near the water's edge carries the weight of the boom and mechanism for varying its level. A loop drive and weighted takeup located in the structure supporting the hinged point provide uniform tension on the belt and satisfactory driving conditions with the boom in any position. This adjustable feature is necessary to diminish breakage of coke and to meet varying water levels.

BARGE LOADING AND UNLOADING

The waterway is free. Barge transportation, eliminating transfers, permits delivery of large tonnages with a minimum of handling. Among advantages of the haul of coke by river is that of low degradation which is important with blast furnace coke. Loading and unloading the barges present a problem, the solution of which, in this particular case, was arrived at through construction of conveying systems by the Jeffrey Manufacturing Co.

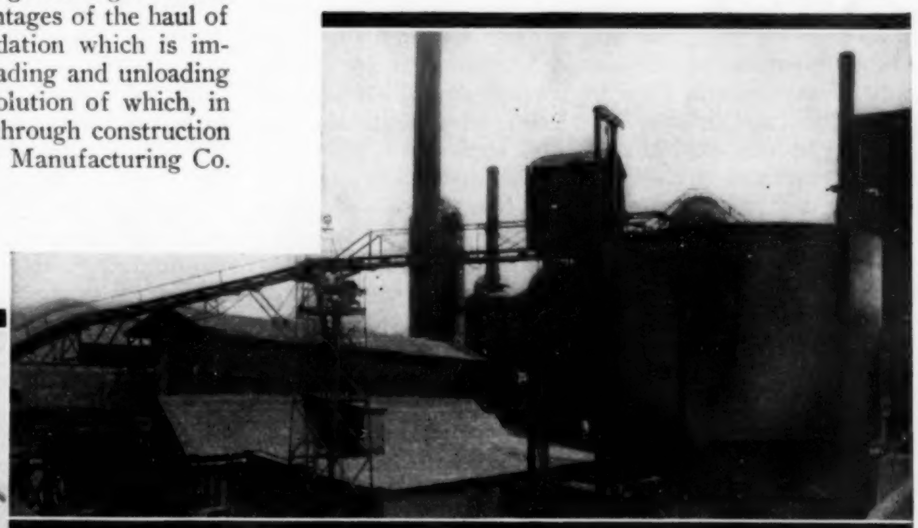
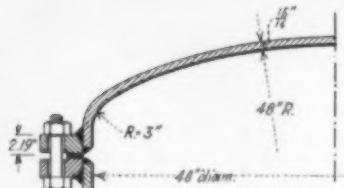


Fig. 6—Continuation of the stationary unit and the continuation of the same belt over an adjustable boom hinged at the tower. The boom is the bridgelike structure extending from this tower to the bin. It is arranged to accommodate different levels of coke. A boot opening in the side of the bin permits the boom to be lowered into it. From the low point the operation of the boom to higher levels is automatic through electrical devices governed by the depth of the coke. With the combination of adjustable boom and the boot opening in the side of the cylindrical bin, breakage at the discharge end is prevented.

Fig. 5—Upper end of movable conveyor is carried on rollers that run on T-rails located on both sides of the stationary section of the upper conveyor. These T-rails are parallel to the tower track up the river bank.



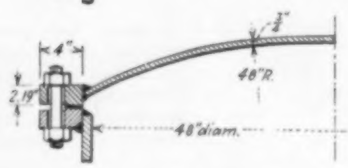


Fig. 1, Above—Conventional removable head

Fig. 2, Below—New type removable head suggested by the author

More Heads for Tanks and HEAT EXCHANGERS

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Editor's Note—This is the last of three articles in which the author has discussed as a general subject the design of heads for pressure vessels and heat exchangers. In the first article he took up the calculation and design of the most usual heads, and in the second, the proportioning of head bolts, flanges and gaskets. In this final article he describes a new, cheaper head, as well as cone bottoms and flat covers.

ONE OF THE THINGS that hamper progress in the technical arts is that certain devices or apparatus *work*. Having worked in an apparently satisfactory manner they are carried along on a kind of momentum and their use continued, when slight changes would improve performance and economy. The head shown in Fig. 1 is a good example of this, for, with its knuckle and knuckle flange, it has been in use so long as to have become more or less traditional.

Before the advent of fusion welding, the knuckle flange was essential for the attachment of the head to the shell by riveting; when a head is intended for permanent attachment, the flange is still useful in adding to the rigidity of the end of the shell as discussed in the first article of this series (December, 1932, pp. 668-72). But in the case of a removable head or cover, with bolting flanges capable of resisting a collapsing force, the design may be simplified and cheapened as in Fig. 2. The flange, besides resisting the bending moment caused by the bolt pull, must also resist the collapsing force produced by the effort of the crown to pull away from the flange, which effort acts along meridian lines of the crown and which can be resolved into horizontal components as has been shown in the discussion of Fig. 4 of the first article. Being bolted together, the two flanges unite in resisting the collapsing force. Unless they are so regarded, there will be required a very large section in a single flange. We shall now design the new head to apply to the problem discussed in the example illustrated by Figs. 5 and 6 of the second article (February, 1933, pp. 70-71).

In this example the assumed working pressure was 250 lb. per sq.in., and the diameter 48 in. With a flange or pair of flanges adequate for the purpose, the new head under fluid pressure will act as a sphere and the stress will be tensile with a magnitude of $48 \times 250/2 = 6{,}000$ lb. per in. of circumference. The determining factor, however, is the attachment to the flange and, assuming an allowable stress of 11,000 lb. per sq.in., and a weld efficiency of 75 per cent, the required thickness is $6{,}000/11{,}000 \times 0.75 = 0.727$ in.—say $\frac{3}{4}$ in.

Along a meridian of the crown the horizontal component of the stress is $6{,}000 \times 0.866 = 5{,}196$ lb. per in. of diameter, or a total of $48 \times 5{,}196 = 249{,}000$ lb. But opposing this is the fluid pressure on an uncertain length of the end of the shell, as discussed in the first article. Assuming this length to be the thickness of the two flanges and an additional length of shell to total 6 in., the opposing pressure is $6 \times 48 \times 250 = 72{,}000$ lb. which, subtracted from 249,000 leaves 177,000 lb. as the force tending to collapse the flanges. We shall ignore the effect of the end of the shell, and assume that the force is resisted by the two flanges only. The critical or dangerous section is through the bolt holes, and the required cross-section is $177{,}000/11{,}000 = 16.1$ sq.in. The width of the flanges is 4 in., and the diameter of the bolt holes 1.5 in., so the required thickness of each flange is $16.1/4(4—1.5) = 1.61$ in. The thickness of the flange as a cantilever was found in the second article to be 2.19 in. so, when designed as such, it provides ample resistance to collapse.

Failure along the diameter is resisted by the united action of the flange and the crown. The approximate section modulus of this section may be found by "massing-up" the section on the axis and finding the desired properties. The form of this "massed-up" section is a wide, thin upper flange representing the top of the crown, then a web forming a series of steps that meet the lower flange, which represents the two sides of the bolting flange minus the bolt holes. The section modulus thus found is always more than required, so it is never necessary to find it after the first trial, which is for the purpose of convincing oneself that a head designed by the foregoing rules will not fail along a diameter. The critical section has been found to be through the weld connecting the flange and the crown.

In Fig. 3 are shown two methods of welding the bolting flange to a head. In sketch *a* the weld is a fillet at the junction of the flange and head. In *c* the flange has been machined to form a V-shaped groove which is filled with the weld metal. For convenience we shall

ignore the fusion of the parent metal and the penetration thereinto of the weld metal and shall assume that the sections of the two kinds of welds are as shown.

A study of *a* will disclose that plane 1–2 of the weld is under a shearing stress while 1–3 is under, nominally, a tensile stress but actually a tearing stress. Were the plane 1–3 to suffer failure, it would begin at 1 and move up rapidly to 3. This kind of weld is analogous to the riveted joint of sketch *b*, a thing to be avoided because a single rivet in the line of stress bears the brunt of the load. In *c* the weld is more favorable to the resistance of the transverse stress, in which respect it is analogous to the riveted joint *d*.

Filling the bottom of the 45-deg. V with weld metal as shown in *c* is somewhat difficult but, as it is at the neutral axis of the section, failure to do so is not very important. The 75 per cent efficiency assumed for the weld in this case makes ample allowance for lack of penetration to the bottom of the V. The excess height of the weld on the head, and the length of the weld in the bolting flange, compensate for any ordinary imperfection. The weld of *a* is far superior to *c*.

The thickness of flange required to resist the bending moment between the bolts need not be considered except in cases of low pressures and correspondingly thin flanges. A formula for the spacing of bolts in cast-iron flanges of steam-engine cylinders and the like, that has the sanction of successful practice is $s = 40\sqrt{t/p}$, in which s is the spacing of the bolts, t the thickness of flange, and p the working pressure in the cylinder. When steel is substituted for cast iron, one is prone to think that for the same thickness of flange, the bolt spacing may be greatly increased, but this is not so. The deflection of a beam within the elasticity of the material varies directly as the total load and as the cube of the span, and inversely as the modulus of elasticity of the material, or as Wl^3/E. As the total load is the product of the unit load or pressure and the span, or pl, the deflection of the flange between bolts varies directly as the 4th power of the span, or l^4. Taking the modulus of elasticity of steel as 30,000,000, and that of cast iron as 15,000,000, the deflection of cast iron is twice that of steel, other factors being equal. For equal deflections,

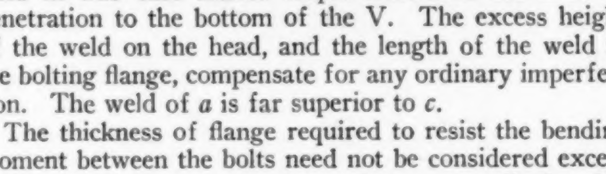
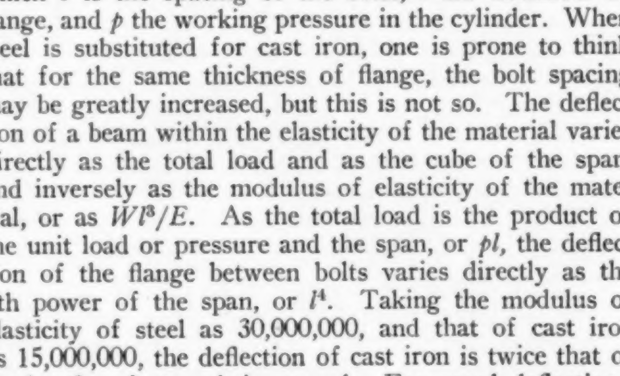


Fig. 3, Above—Two methods of flange attachment with comparable riveted structures

Fig. 4, Below—Stresses in a typical cone bottom



then, the span L of the steel beam may be greater than the span l of the cast iron beam by the ratio $L^4/2 \times l^4$; and $L = \sqrt[4]{2} \times l$, or $1.19 \times l$. The formula for the spacing of bolts in steel flanges is then $s = 48\sqrt{t/p}$.

It should be understood that the use of heat-treated or alloy-steel flanges does not permit greater spacing than found above, because the problem is one of deflection and, as the modulus of elasticity of any steel is nearly 30,000,000, the deflection is constant regardless of its high elastic limit or ultimate strength.

Occasionally pressure vessels terminate in cones as, for instance, the hopper bottoms of rendering tanks and the like. Hoppers usually have a slope of 60 deg. with the horizontal to facilitate the discharge of the contents. Dished heads of pressure vessels with pipe connections, which necessitate a large reinforcing plate, might advantageously be replaced with a cone as shown in Fig. 4. The maximum stress in the cone is tangential and is found at its junction with the shell. It is determined, as in a cylindrical shell, by multiplying the working pressure by the perpendicular distance, R_1, to the center line of the tank. The meridian stress, S_m, equals the longitudinal stress in the shell multiplied by the cosecant of the angle of the cone with the radius of the shell, or PR, cosec $\theta/2$. The stress at any other point on the cone is found similarly, using the cone radius at the point.

To illustrate the method of design we shall use, for example, a shell 48 in. in diameter with a cone whose angle θ is 60 deg. The working pressure is 250 lb. per sq.in. The stress in the shell is PR or $250 \times 24 = 6{,}000$ lb. per lineal in.; the tangential stress in the cone at its junction with the shell is $PR_1 = PR$ cosec θ, or $250 \times 24 \times 1.155 = 6{,}930$ lb. per lineal in., and the meridian stress at the end of the shell is PR cosec $\theta/2$, or $250 \times 24 \times 1.155/2 = 3{,}465$ lb. per lineal in., or one-half the tangential stress. In the case of cones whose angle θ is flatter than 45 deg., consideration should be given the collapsing force in the end of the shell.

Occasionally conditions—or convenience—call for flat heads or covers on pressure vessels. In Fig. 5 is an isometric drawing of a flat head of a shell 24 in. inside diameter under 250 lb. per sq.in. working pressure. The left half of the drawing represents a steel, and the right half, a cast-iron shell and cover. The thickness of the steel with a working stress of 11,000 lb. per sq.in., and a joint efficiency of 75 per cent, is $24 \times 250/2 \times 11{,}000 \times 0.75 = 0.364$ in.—say $\frac{3}{8}$ in. The thickness of the cast-iron shell with 3,000 lb. per sq.in., is $24 \times 250/2 \times 3{,}000 = 1$ in. The gasket is $1\frac{1}{4}$ in. wide and it is assumed that the fluid pressure is exerted over the area bounded by its inner circumference and equals $24^2\pi 250/4 = 113{,}000$ lb.

We shall assume as in the previous article that the fluid pressure between the gasket and its seat varies uniformly from 250 lb. at the inner edge to 0 lb. at the outer edge. The pressure diagram is then a triangle, which makes the average pressure one-half the maximum, or 125 lb. per sq.in. The fluid pressure on the gasket is then the average pressure times the area of the gasket, or $125(551.6 - 452.4) = 12{,}400$ lb., which may be assumed as concentrated on a circle of 24.83 in. diameter.

The pressure on the gasket necessary for fluid tightness was assumed to be the unit working pressure over the area of the gasket, or in this case 250(551.6 —

452.4) = 24,800 lb., which is assumed to act on a resultant circle through the outside of the middle third of the gasket, or on a circle of 25.33 in. diameter. The total pressure resisted by the bolts is the sum of the three pressures just found, or 150,200 lb.

It is necessary that the bolts clear the gasket so we shall assume a bolt circle of 28 in. diameter. With a spacing of 3.5 in., the number of bolts is $28\pi/3.5 = 25.1$, say 26 bolts, since in the present case there is no need of using a multiple of four as in pipe work. Dividing the total pressure by the number of bolts we have $150{,}200/26 = 5{,}770$ lb. as the pressure exerted by each nut on the resultant-pressure circle. In the second article (February) it was shown that in cases where the gasket lay entirely within the inside of the bolt holes, there was some eccentricity of the load carried by the bolts, which eccentricity was assumed as one-fourth the diameter of the bolt.

For combined axial and bending loads the maximum fiber stress is found by the equation $f_s = P/A + M/S$, in which P is the load applied with the assumed eccentricity; A the sectional area of the bolt at the root of the thread; M the bending moment; and S the section modulus of the bolt at the root of the thread. Using common steel bolts and an extreme fiber stress of one-half the elastic limit of the metal, or 18,000 lb. per sq.in., the equation becomes $18{,}000 \times 1.18\,d/4 \times 0.098\,d^3$, in which d is the diameter of the bolt at the root of the thread; the expression $1.18\,d/4$ is the eccentricity, in which the quantity $1.18\,d$ gives the approximate nominal diameter of the bolt; and the expression $0.098\,d^3$, the section modulus. Solving for d we have $d = \sqrt{24{,}700/18{,}000} = 1.17$ in. The nearest commercial size is $1\frac{3}{8}$ in. which is 1.16 in. at the root of the thread. Smaller bolts could be used if they are heat treated.

The distance from the bolt circle to the circumference of the cover should accommodate the nuts. The long diameter of the hexagonal nut of a $1\frac{3}{8}$-in. bolt is $2\frac{1}{2}$ in. Half of this is $1\frac{1}{4}$ in., and making the distance from the bolt circle to circumference $1\frac{1}{2}$ in., the diameter of the cover is 31 in.

Referring to Fig. 5 we find the positions of the various resultants. The pressures found in the foregoing are divided by two to get the pressures on each half of the cover, resulting in 56,500 lb. for the fluid pressure within the inner circumference of the gasket; 6,200 lb. for the fluid pressure on the gasket; and 12,400 lb. as the pressure assumed as necessary for fluid tightness, or what might be termed the final gasket compression. The sum of the three, 75,100 lb., is the load carried by the bolts in one-half of the cover.

The centroid of the semi-circular area within the gasket is $0.212 \times 24 = 5.08$ in. from the diameter; the centroid of the semi-circular arc representing the resultant of the fluid pressure on the gasket is $24.83/\pi = 7.9$ in.; the centroid of the semi-circular arc representing the resultant of the final gasket compression is $25.67/\pi = 8.17$ in.; and the centroid of the semi-circular arc representing the resultant of the nut pressure is $27.31/\pi = 8.7$ in. from the diameter.

Taking moments about a diameter, the moment of the resultant nut pressure is $75{,}100 \times 8.7 = 653{,}000$ in.-lb.; the moment of the final gasket compression is $12{,}400 \times 8.17 = 101{,}300$ in.-lb.; the moment of the fluid pressure on the gasket is $6{,}200 \times 7.9 = 49{,}000$ in.-lb.; and the

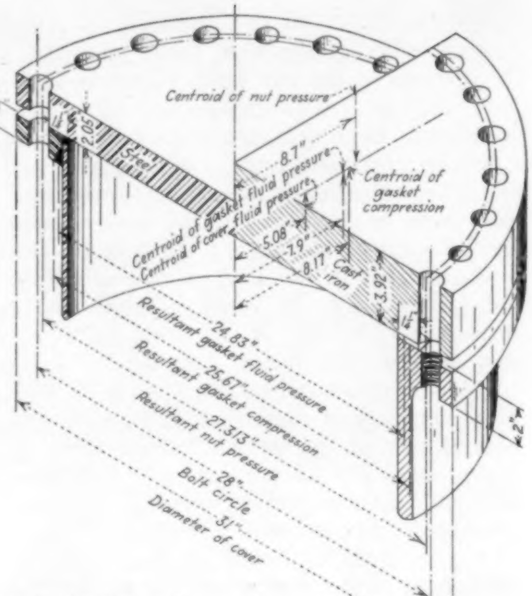


Fig. 5—Analysis of steel and cast-iron flat heads

moment of the pressure under the head is $56{,}500 \times 5.08 = 287{,}000$ in.-lb. Subtracting the sum of the last three from the first we have $653{,}000 - 437{,}300 = 215{,}700$ in.-lb., as the bending moment on a diameter of the cover. The required section modulus of a steel cover with a fiber stress of 11,000 lb. per sq.in. is then $215{,}700/11{,}000 = 19.6$ in.^{3}, and for a cast-iron cover with a fiber stress of 3,000 lb. per sq.in., is $215{,}700/3{,}000 = 71.9$ in.^{3}.

Failure of the cover would take place through two opposite bolt holes on a diameter, so the net width of the section under transverse stress is $31 - (2 \times 1.5) = 28$ in. The required thickness of the steel cover is then $t = \sqrt{6 \times 19.6/28} = 2.05$ in., and the thickness of the cast-iron cover is $t = \sqrt{6 \times 71.9/28} = 3.92$ in.

The foregoing method of design, while correct in the assumption that failure of the cover would be along a diameter through two opposite bolt holes, is not correct in the assumption that all the bolts would participate in the bending moment. It is obvious that the bolts in the holes through which failure occurs do not contribute to the bending moment; in fact, they carry a portion of the pressure. On the other hand, if the sector carried by the remaining bolts is considered, the moment arms are increased and the net result is only a slight reduction of the bending moment as found. So, for the sake of simplicity, the foregoing method should be used with the assurance that any error is on the side of safety.

In the second article in February, the design of the flanges has been discussed by which method the welded flange in this case is found to be $1\frac{3}{8}$ in. thick. If the cast-iron flange is thick enough to accommodate 1.5 diameters of the stud bolt, it will be thick enough to resist the bending moment. The fillet is very effective, coming as it does in the plane of the maximum bending moment.

Occasionally one is required to design rectangular pressure vessels or box-shaped headers with flat covers. When the shape of the cover is square, or nearly square, it can be regarded as supported at all edges, and designed in the same manner as the circular cover. The bending

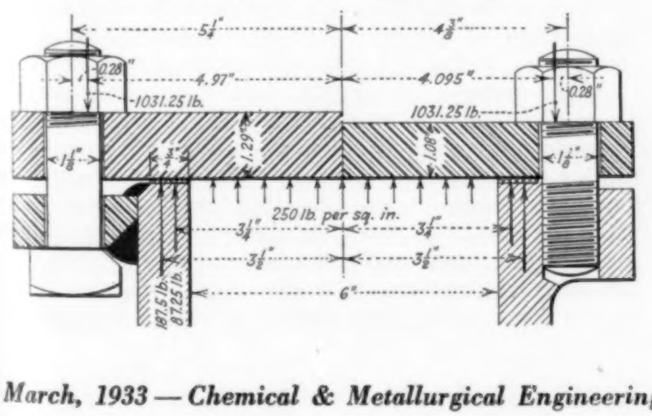
moment per inch of length of the diagonal of a square cover is the same as the bending moment per inch of diameter of a round cover whose diameter equals the square. So, for practical purposes, the square cover may be designed as a round cover whose diameter equals the length of the square.

When the length of the cover exceeds 1.5 times the width, the end supports have little or no effect on the stresses in the middle of the length. This becomes clear when we understand that, for a constant load, the deflection of a beam varies as the cube of the span. But, as in the present case, where the load increases with the span, the deflection increases as the 4th power of the span. So, for a case in which the length of the cover is 1.5 times its breadth, the proportion of load carried by the transverse fibers is $l^4/(l^4 + b^4)$, or nearly 84 per cent of the total. And for a length-to-breadth ratio of 2, the transverse fibers carry more than 94 per cent of the load. It would seem then that a unit width of a rectangular cover should be designed as a beam whose span is its breadth, and have the assurance that any error is on the safe side.

In Fig. 6 is a cross-section of the cover of a box header of a heat exchanger. Steel plate is used in this case because it is cheaper than cast iron. The working pressure is 250 lb. per sq.in. As before, the width under full fluid pressure is assumed to be between the inside edges of the gasket, or 6 in. The total pressure across the span is therefore 1,500 lb. per in. of length of cover. The width of the gasket is ¾ in. and the fluid pressure is assumed to vary from a maximum to zero or an average of 125 lb. per sq.in., over the width, which makes this pressure 93.75 lb. per in. of length of cover, and its resultant is assumed to act at the center of gravity of the triangle representing the pressure, or at one-third of its width from the inner edge. The extra pressure necessary to insure tightness is assumed to equal the unit fluid pressure over the area of the gasket, or $0.75 \times 250 =$ 187.5 lb., and to act on the outside of the middle third. The last two forces can be combined into a single one acting along their resultant, but this would involve more labor than the method used here.

Under the cover the total pressure is $(6 \times 250) + (2 \times 93.75) + (2 \times 187.5) = 2{,}062.5$ lb. per in. of length. With bolts spaced 3.5 in., the average load carried by each is $2{,}062 \times 3.5/2 = 3{,}610$ lb. Assuming as before that this load is applied to the nut on a line one-fourth of the diameter of the bolt from its center, and applying the formula for the combined axial and bending loads, using a fiber stress of 18,000 lb. per sq.in., the diameter of the bolt at the root of the thread is $d = \sqrt{15{,}870/18{,}000} = 0.94$ in., which is nominally a 1⅛-in. bolt.

Fig. 6—Two types of box header construction



A unit length of the cover is a simple beam whose reactions are at the nuts, and according to the foregoing, the beam carries a uniformly distributed load of 1,500 lb., two concentrated loads of 93.75 lb., and two concentrated loads of 187.5 lb., as shown in Fig. 6. The left-hand half of the figure shows the design using throughbolts, while the right-hand half shows the use of stud bolts. Either cast iron or welded steel may be used.

The use of throughbolts, necessitating room for the heads, has the effect of lengthening the span of both cover and flange, and consequently their thickness. The stud bolts, in addition to reducing the spans, also offer some restraint to bending of the flange and the side of the box by reason of the tight fit in the threaded hole. Incidentally, in the design of a box of this kind, it should not be forgotten that the sides are subject to the bending moment induced by the pull of the bolts, in addition to that caused by the fluid pressure.

In order to keep the bending moment at a minimum, the head of the throughbolt should be brought as close to the side of the box as possible. Omitting the weld fillet opposite the bolt holes will permit the head to be brought into actual contact with the side. An alternative is chamfering the head of the bolt as shown in the figure.

The thickness of the cover is found by taking moments about the middle of the span. Multiplying the nut pressure per inch of length, or 1,031.25 lb., by its distance from mid-span, we have $1{,}031.25 \times 4.97 = 5{,}125$ in.-lb., which we shall call the counterclockwise moment. The clockwise moments are: the fluid pressure on one-half the span times the distance of its center of gravity from mid-span, or $250 \times 3 \times 3/2 = 1{,}125$ in.-lb.; the resultant of the gasket fluid pressure times its distance from mid-span, or $93.75 \times 3.25 = 305$ in.-lb.; and the resultant of the gasket compression times its distance from mid-span, or $187.5 \times 3.5 = 656$ in.-lb. Subtracting the sum of the three clockwise moments from the counterclockwise moment we have $5{,}125 - 2{,}086 = 3{,}039$ in.-lb. as the net bending moment at mid-span. With an allowable fiber stress of 11,000 lb. per sq.in., the thickness of the cover is $t = \sqrt{3{,}039 \times 6/11{,}000} =$ 1.29 in.

The thinner cover of the right-hand half of Fig. 6 is the result of bringing the bolt in as close as possible to the gasket.

It is sometimes thought that this kind of cover is a restrained beam, and as such can be designed for a smaller bending moment than in the foregoing. A moment's reflection, however, will convince one that the condition necessary to restraint—that is, that the ends of the loaded beam remain in their original position—is absent. If the gasket extended to the outer edge of the cover, then there would be restraint, but the advantages of the narrow gasket would be lost.

In covers of short span, subjected to high pressure, the flexural theory does not strictly apply, and shearing stress may be the determining factor. Very short spans should, therefore, be investigated for shear as well as for bending moment. In some cases a cover designed for bending moment may be so thin as to cause excessive shearing stress. It is to be borne in mind that the shearing strength of steel is about three-fourths of its tensile strength.

Avoiding Pitfalls in

PUMP SUCTION SYSTEMS

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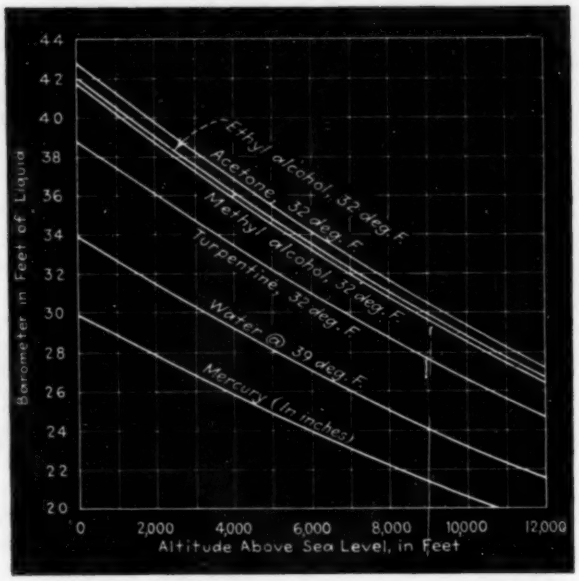

Fig. 1—Liquid barometers at varying altitude

IN ANY pumping system the most vulnerable part is the suction. It is not to be inferred that a good suction system is difficult to design or to build—for it is not, usually—but a poorly designed line will have a far more detrimental effect than a similar oversight would have on the discharge side and may prevent the functioning of the pump altogether.

Water in most suction lines is at a pressure less than atmospheric. For this reason the first requirement is that suction piping must be air tight. The next requirement is that the line must be designed so that the tendency to form air pockets is minimized. There should be a continual down-slope from the pump to the well, and offset rather than concentric reducers should be used at the pump suction as it is obvious that there is danger of an air pocket when using the latter fitting.

No matter how perfect the suction piping system may be, there is a maximum lift beyond which the pump will not function. This maximum will vary depending upon the liquid, its temperature, the barometric pressure, the quantity to be pumped, the pump, and the suction piping system. Cold fresh water at sea level will rise in a water barometer approximately 34 ft. Similarly, in the case of a pump with a perfect vacuum established in the casing, the water will rise to the pump center if it is 34 ft. above the open surface of the suction well. This, however, would be a static condition. The minute flow is attempted, the losses from friction in the piping and in the pump would diminish the height to which the water would rise in the suction piping. Therefore, unless the pump is set lower to allow for various losses, there can be no flow.

Friction loss is not the only factor diminishing the suction lift, however. Unless the water is very cold, there will be an appreciable tendency to vaporize at low pressures. It is obvious that any considerable vaporization of the water will break the suction column. Hence, it is impossible to allow the absolute head to drop to a pressure equal to the vapor pressure if the pump is expected to function. In practice, it is necessary to allow more than the vapor pressure because of air dissolved in the water. At 68 deg. F. and sea level, 1 cu.ft. of water can dissolve 0.019 cu.ft. of air. At reduced pressure this air will expand and tend to form bubbles.

Evolution of water vapor, air or gas will cause an action called cavitation. This is the creation of an empty space in the water, that is, a space under a much lower pressure than in the adjacent portions of the system. Cavitation can also be caused by sudden change in the direction of flow, or by sudden change in the velocity of flow. If only just enough absolute pressure exists at the pump impeller entrance to prevent boiling or liberation of gas, any slight disturbance may upset the equilibrium and start cavitation. For this reason, it is not advisable to figure too closely, nor to locate an elbow at or near the pump in the suction line.

To recapitulate, when dealing with cold water at sea level, there is about 34 ft. of atmospheric pressure (in terms of feet of water) available for forcing the water from the suction well to the pump. In order that flow may exist, this 34 ft. of pressure must:

(*a*) Raise the water a distance equal to the static suction lift.

(*b*) Overcome the friction loss of the suction piping.

(*c*) Overcome the friction loss inside the pump, *i.e.*, from the suction flange to the impeller eye.

(*d*) Provide the greatest velocity head, *i.e.*, the velocity head at the smallest cross-section.

(*e*) After these deductions are made—*i.e.*, (*a*), (*b*), (*c*), and (*d*)—the feet head remaining (which will be pressure at the impeller eye) must be sufficient to offset vaporization of the water, prevent liberation of air or gas bubbles, and supply a margin to avoid cavitation.

Of the factors, (*a*) to (*e*) inclusive, the static suction lift and the friction loss in the suction piping can be determined from the installation, the liquid to be handled and the capacity to be handled. The vapor pressure of the liquid is also something that can be ascertained, while the extra that must be allowed to prevent air or gas bubbles from forming is a matter of experience with the water in question. The greatest velocity head may be that through the pump suction nozzle but this will not

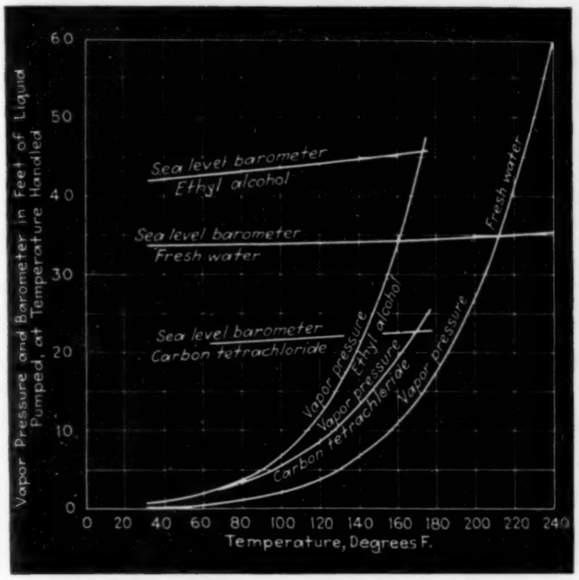

Fig. 2—Vapor pressures at varying temperature

be the case if the impeller eye area is smaller. However, the internal pump friction is something that the man in the field cannot calculate. It is questionable whether anyone can calculate it beforehand, but a pump manufacturer can develop it experimentally.

Although dynamic suction lifts as high as 24 ft. have been reported for centrifugal pumps handling cold fresh water, the highest practical dynamic lift to count on at sea level is about 20 ft. This means that the total head of water at the suction flange, referred to the pump center, is 14 ft. absolute. The velocity at the suction nozzle for such a lift will scarcely exceed 10 ft. per second, which corresponds to a velocity head of slightly over 1½ ft. This means that the pressure head is 12½ ft. absolute. An average water temperature is 70 deg. F., at which the vapor pressure is 0.78 ft. of water. Thus it will be seen that almost 12 ft. is available to overcome internal pump friction, prevent the formation of air bubbles and guard against cavitation. This may be considered an average case—the amount might be greater in case the water contained much gas in solution, or occasionally less with water comparatively free from air.

Although it is not possible for an operator, who is usually limited as to test facilities, to calculate the extreme suction lift that a new pump will handle, it is possible to determine what a pump already successful on one duty can do in another installation. For instance, if a 10-in. pump with a 12-in. suction nozzle has been successfully lifting 2,000 g.p.m. for 20 ft. dynamic suction lift at sea level, what suction lift will be possible at 10,000 ft. altitude? The only change in the conditions of pumping is that of the barometer (see Fig. 1) which has decreased from 33.8 ft. of water at sea level to 23.2 ft. at 10,000 ft. altitude. The limiting dynamic suction lift will, therefore, be decreased by the difference (10.6 ft.) to 9.4 ft.

On the other hand, assume that the pump is to remain at sea level while the water temperature is to be changed from 70 deg. to 212 deg. F. The velocity head for 8.17 ft. per second is approximately 1 ft., and the vapor pressure at 70 deg. is about ½ ft. (see Fig. 2). If the friction loss of the suction system were 6 ft., the static suction lift would be 20 — 6 = 14 ft. and the absolute static suction head, 34 — 14 = 20 ft. suction. Under the cold water conditions we have the following:

		Heads Feet
Absolute static suction head		20
Less: Friction of suction system	6	
Velocity head	1	
Vapor pressure	½	7½
Pressure head available to overcome internal friction of the pump, prevent liberation of air bubbles, and prevent cavitation		12½

The change to water at 212 deg. F. changes the water barometer, the vapor pressure, the friction loss of the suction system, and the internal friction loss of the pump. In the 12-in. suction pipe, the flow number of the cold water, DV/K, is 98. The flow number for the hot water will be 331, corresponding to a reduction of friction of about 10 per cent. This reduction would apply if the losses were due only to straight piping. Probably so large a reduction does not apply for losses caused by entrance and fittings. Usually, therefore, such a decrease in friction is not allowed in problems of this kind—it is ignored because it is small and because to ignore it is to be on the safe side. The same omission is made in the case of the internal friction of the pump, where the decrease would be difficult to calculate in any event. Hence, the new case is:

	Heads, Feet
Friction of suction system	6
Velocity head	1
Vapor pressure (Fig. 2)	35
Pressure head margin as before	12½
Absolute static suction head	54½
Less hot water barometer (Fig. 2)	35
Static suction head (gage)	19½

If, instead of water, this same pump is to handle carbon tetrachloride at 70 deg. and at sea level, the changes involved are again the barometer, the vapor pressure and the friction. The friction loss in pumping the fluid will be slightly less than in the case of cold water, and there again, the slight difference can be ignored, since it is on the safe side. The figures will be:

	Heads, Feet
Friction of suction system	6
Velocity head	1
Vapor pressure (Fig. 2)	2½
Pressure head margin as before	12½
Absolute static suction head	22
Less CCl_4 barometer (Fig. 2)	21
Static suction head (gage)	1

The friction loss in the case of ethyl alcohol at 70 deg. F., however, will be slightly greater than for cold water, the ratio for a 12-in. pipe and 2,000 g.p.m. being about 6 to 5. As difference is not on the safe side, the proper assumption is that this increase in the straight pipe friction is also manifest in the fittings of the suction line. Furthermore, some increase should be made in the margin of pressure allowed for internal pump friction. The figures might be:

	Heads, Feet
Friction of suction piping	7½
Velocity head	1
Vapor pressure (Fig. 2)	3
Pressure head margin	13½
Absolute static suction head	25
Less ethyl alcohol barometer (Fig. 2)	43
Static suction head (gage)	18

In other words, this case permits a static suction lift of 18 ft., or a dynamic suction lift of 18 + 7½ = 25½ ft.

How Spirit Varnishes May Be Standardized

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THROUGH improvements in the method of manufacture during the last few decades, spirit varnishes of superior quality have come into use. Considerable confusion exists from the old custom of the trade in expressing the body of such varnishes in terms of the weight of resin purchased for this purpose, and authorities disagree as to how spirit varnishes should be standardized. This important industrial subject is in need of clarification.

Standardization of Natural Resins

Natural resins necessarily vary considerably in their composition. Few methods have been developed for the standardization of these substances, with the possible exception of shellac. In consequence it is customary in commerce to consider the natural impurities in such materials as an integral part of the resin, and where allowances are made, it is on grade alone. This has led to the practice of expressing the body of spirit varnishes in terms of the weight of material originally taken for solution in the wood spirits or denatured alcohol. For example a "5 lb. per gal." varnish contains the resin from 5 lb. of shellac, copal, or other resin as it was originally added to a gallon of the solvent.

The original method of manufacture thus consisted in dissolving the designated amount of resin in the spirits and allowing this crude varnish to stand so that some of the impurities would settle out, or filtering the varnish by hand through cloth bags. These practices still prevail more or less among the many small users and manufacturers of spirit varnishes, who lack the equipment of modern machinery for clarification. In these cases little if any attention is paid to the true resin content of the finished product, since this section of the trade has no means for analyzing its compositions, nor does competition with a large variety of substitute products warrant the expense of maintaining such facilities. Not only do the substitute products contain cheap film forming substances of almost any kind, but many small consumers are interested only in price and the appearance of the film and not in the value received for their money. In the case of shellac this results, in times of high prices for this commodity, in a considerable curtailment of production and during periods of low prices in direct competition with a non-standardized field.

On the other hand, in modern large scale manufacture, where organizations have striven for quality, they must not only meet this competition in the open market, but must also sell on specification. In this field products are prepared from stock-solutions, since it is more economical in such manufacture to handle varnishes of heavy "cuts" or percentage of resin, and after clarification by centrifuging or other modern filtration machinery to adjust the body to that demanded by the trade, which is usually "4 to 5 lb. cuts." The consumer must further thin these varnishes in the case of shellac to 2 lb. per gal. to obtain best results. When one considers the question of the impurities in the original resin, it is obvious that the bulk of non-volatile constituents in the finished varnish will not equal the amount of resin used in its preparation. Although such manufacturers analyze their finished products and maintain a careful control on raw materials, they are placed at a severe disadvantage unless some standard is employed which compares with that used by the trade in general.

It is difficult at best to write specifications for spirit varnishes which are a true estimate of their value. For this reason no standard set of specifications exists. In drafting such a set, many factors have to be considered.

In this connection, the moisture content of bleached shellac presents a problem. This resin is probably the most widely used in the spirit varnish field. Authorities on shellac differ in their opinion as to what is the best moisture content for storage purposes. Some hold that a low moisture content is desirable, while there are contracts calling for a minimum of 4 per cent. Since bleached shellac loses moisture on shipment, it is necessary to allow a maximum of 6 per cent on general specifications in order to meet the latter demand. This, however, does not prevent purchase, at a special price, of material which has been further dried to meet individual specifications of a lower maximum.

Interest of Small Consumers

On the other hand, there are always amounts of bleached shellac sold to small consumers whose primary interest is in purchasing at the lowest cost a material which can be dissolved in alcohol and used directly. This large section of the consumer group is interested in moisture content only insofar as the solvent is not diluted to such an extent as to give difficulties in the preparation of the varnish or in its application. This large group will be opposed to any inflexible standard for spirit varnish. The extra cost of analysis and labor

to adjust the varnish to standard on a non-volatile basis would prohibit its sale for many applications where the work is under contract.

For the above reasons, the trade has retained the antiquated system of specifying in terms of pounds per gallon. Certain corrections are thus necessary in order to correlate the percentage non-volatile obtained on analysis with the body of a varnish based on the original resin dissolved.

Where the body of a spirit varnish is unknown, it may be obtained in accordance with accepted practice. A weighed portion of the varnish is dried according to standard methods and the weight of the residue of non-volatile matter obtained. Duplication should give a result which agrees within 0.2 per cent. The methods for obtaining non-volatile in oil varnishes and even the standard methods adopted for shellac varnish in this matter are open to criticism, since it is impossible to remove all the solvent at the temperatures specified without losing a certain amount of water liberated as a result of an internal chemical reaction in the shellac. It can be shown that shellac will lose water of chemical constitution up to 300 deg. C. Lower temperatures than those specified for longer periods of time would give truer values, more in accord with what is obtained on actual application.

In calculating the percentage of shellac for clarified orange varnishes, the weight of residue is divided by the factor 0.95. This is based upon the fact that 2 per cent is always allowed for possible loss in moisture, in addition to the 3 per cent of insoluble matter which is practically eliminated for the average grades of shellac used in the modern methods of varnish production. In a similar manner for bleached shellacs the weight of residue is divided by the factor 0.94 to allow for the possible loss of 6 per cent moisture in these grades. Shellac wax has always been considered as part of the resin when below the specified limits. From the percentage of shellac, the body in pounds per gallon can be obtained directly by consulting the suitable tables prepared for this purpose.

Confusion in Use of "Shellac"

Percentage of shellac is here employed as throughout the article in the customary sense, referring to the original resin which contains as can be seen the allowable amount of impurities in accordance with the specifications. This is in accord with its usage in the U.S.S.I.A. booklet, but at variance with the practice set forth in the A.S.T.M. D 29-29 T and the U. S. Government specifications where there is a reference to the clarified non-volatile resin obtained on analysis of a varnish. This use of the word, shellac, in a modified sense has led to confusion and in certain cases to inconsistencies in different sections of a specification.

Products of specified composition may be prepared from stock solutions in one of three ways depending upon the cut of the stock and the body desired for the specified varnish. The problem most commonly encountered in the manufacture of shellac varnishes is the preparation of a definite composition by diluting varnishes of heavy body with denatured alcohol. However, it is occasionally desirable to prepare varnishes by dissolving additional resin in a lower cut or to blend products of different concentrations.

There are several methods by which the necessary calculations may be made. Most of those now in use in the trade require several notations which are both cumbersome and time consuming, and it appears that Schmidt's rectangular method (Van Nostrand's Chemical Annual, 1926, p. 819) for the formation of mixtures of definite composition has been widely overlooked. The examples which follow illustrate the utility of this method and show how it is possible to condense the varied mathematical steps into equations from which the answer may be directly obtained on a slide rule. In plant practice, it is more convenient to express results in volumes based upon the volume of the original or stock varnish. This method has been followed.

Dilution Formula for Varnish

Where a more dilute varnish is desired than the heavy cut of shellac had as stock solution, the dilution formula may be derived in the following manner:

A = percentage by weight of shellac in the original varnish which is to be diluted;
B = percentage by weight of shellac in the desired varnish;
C = weight in pounds of 1 gal. of the original varnish;
D = weight in pounds of 1 gal. of the alcohol;
E = number of parts by weight of the varnish to be diluted;
F = number of parts by weight of the alcohol to be added;
G = volume in gallons of varnish to be diluted;
H = volume in gallons of the alcohol to be added;
J = above volume of alcohol expressed as a percentage of the original varnish volume.

By the rectanglar method it can be seen that, $A - B = F$; and $B = E$, since the concentration of shellac in the alcohol is zero. By definition, $F/D = H$; $E/C = G$; and (100) $H/G = J$. By substitution the following dilution formula is obtained:

$$J = \frac{100\,(A - B)\,C}{BD}$$

Example: To dilute with alcohol 60 gal. of a 6-lb. cut of shellac varnish to a 4-lb. cut. From the tables (Official Methods of Analysis, U. S. Shellac Importers' Assoc.) a 6-lb. cut of shellac varnish required 46.98 per cent of shellac, and a 4-lb. cut requires 37.11 per cent. The 6-lb. cut weighs 7.987 lb. per gal., and 1 gal. of alcohol (No. 1 special according to regulation No. 61, U. S. Internal Revenue) weighs 6.7793 lb.

$$J = \frac{100 \times (46.98 - 37.11) \times 7.987}{37.11 \times 6.7793} = 31.33 \text{ per cent}$$

$$60 \times 0.3133 = 18.8 \text{ gal. of alcohol required.}$$

When it is found by analysis that a varnish is low in body, the condition may be corrected by the addition of a calculated weight of dry shellac:

K = percentage by weight of alcohol in the original varnish;
L = percentage by weight of alcohol in the varnish desired;
M = weight in pounds of 1 gal. of the original varnish;
N = number of parts by weight of the original varnish used;
P = number of parts by weight of the dry shellac required;
Q = volume in gallons of the original varnish;
R = weight in pounds of dry shellac needed per gallon of the original varnish.

As above,

$K - L = P$, and $L = N$; $N/M = Q$, and $P/Q = R$.

By substitution the following concentration formula is obtained:

$$R = (K - L)\, M/L$$

On the other hand, it may be desirable to prepare a specified product by mixing two varnishes of different concentrations. The amount of each varnish may be obtained in the following manner:

A = percentage by weight of shellac in the original varnish (varnish 1);
B = percentage by weight in the varnish desired (varnish 2);
C = percentage by weight in the varnish to be added (varnish 3);
D = weight in pounds of 1 gal. of varnish 1;
E = weight in pounds of 1 gal. of varnish 3;
F = number of parts by weight of varnish 1 required;
G = number of parts by weight of varnish 3 required;
H = volume in gallons of varnish 1;
J = volume in gallons required of varnish 3;
K = the above volume of varnish 3 expressed as a percentage of the varnish 1 volume;
L = volume in gallons of the varnish desired, varnish 2;
M = the above volume of varnish 1 expressed as a percentage of the varnish volume desired;
N = the above volume of varnish 3 expressed as a percentage of varnish volume desired.

By the rectangular method, $A - B = G$, and $C - B = F$. By definition, $F/D = H$, and $G/E = J$; and since there is no expansion or contraction on mixing shellac varnishes, $H + J = L$; $(100)\, J/H = K$; or $(100)\, H/L = M$, and $(100)\, J/L = N$. Substituting the following blending formulas are obtained:

$$K = \frac{100(A-B)D}{(C-B)E}; \quad M = \frac{\dfrac{100(C-B)}{D}}{\dfrac{(A-B)}{E} + \dfrac{(C-B)}{D}};$$

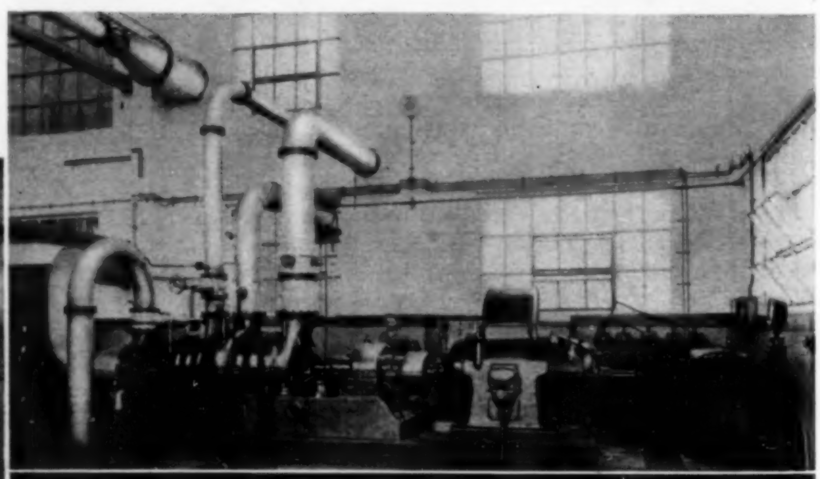
and

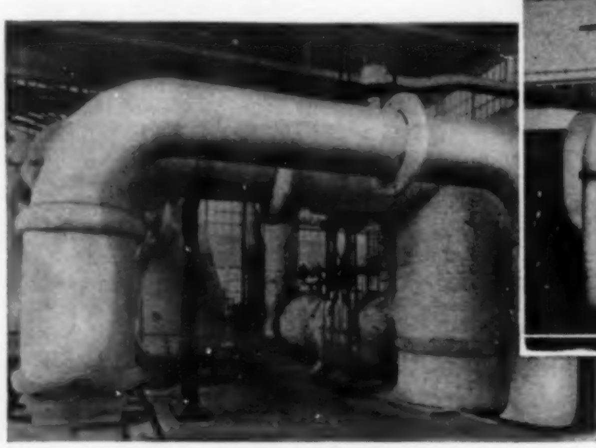
$$N = \frac{\dfrac{100(A-B)}{D}}{\dfrac{(A-B)}{E} + \dfrac{C-B}{D}}$$

The author wishes to acknowledge the suggestion of O. M. Olsen of William Zinsser & Co., to consider the possibilities for condensing shellac varnish calculations. The above formulas have resulted from his suggestion.

PRODUCING CONCENTRATED NITRIC ACID

IN the August, 1932, number of *Chem. & Met.,* Giacomo Fauser discussed his process for the production of concentrated nitric acid by direct synthesis avoiding absorption. In that article he discussed the catalyzers and heat interchangers of stainless steel; the absorption system for compressed nitrous gases with storage tanks for nitric acid; and the turbocompressor for nitrous gases, operating at 8 atm., and driven by waste-steam turbines. These interesting installations which Fauser mentioned in his article are shown in the accompanying illustrations.





BOOKSHELF

Unit Processes or Operations?

Unit Processes and Principles of Chemical Engineering. By *John C. Olsen*, Ph.D.,D.Sc. Published by D. Van Nostrand Co., Inc., New York. 558 pages. Price, $5.

Reviewed by *A. W. Hixson*

TEXTBOOKS, in the opinion of this reviewer, constitute the most important part of engineering literature. Their specific function is to present in clear and concise manner fundamental principles and the best method of their application. The writer of a textbook, especially a treatise on the principles of engineering, should assume the responsibility for maintaining high standards and should be held to a strict accounting. A good textbook should have a logical plan and a well-ordered flow of carefully selected and coordinated subject matter which should be presented with authority and precision. Correct language used in simple and attractive style is a prime requisite.

Wherever possible and practicable, the principles, definitions, and laws should be treated quantitatively. Well chosen illustrations of the application of principles using examples from actual practice enriches the treatment of the subject and increases the reader's interest. Carefully selected and tested problems in sufficient number to give the student a good working knowledge of the use of both theoretical and applied data are an important part of a textbook of chemical engineering. A first book on principles, necessarily limited in its treatment, should include a carefully selected, classified bibliography, that will direct the student to the proper sources for further information and study. And, finally, the work must be up to date and sufficiently comprehensive to give the student a good, general understanding of the whole subject.

Viewed coldly and dispassionately in the light of these ideals, it must be admitted that Professor Olsen and his group of able collaborators have written a textbook which falls far short of meeting desirable, high standards. It is the sort of a chemical engineering *pot-pourri* of which, unfortunately, there are already too many in existence.

Of the plan to be followed in this book, the author-editor states, "to this end he has endeavored to develop this book so as to present (a) the fundamental chemical and physical-chemical principles which determine the course of any given chemical reaction, (b) the so-called unit processes (*sic*) which must be utilized in carrying out the given reaction on a commercial scale and (c) the combination of these processes in their proper sequence and coordination, etc." Of part (a) of this plan it must be said that there is practically nothing in the book. The second part (b) is incomplete to the extent that such important unit operations as agitation and mixing, crushing and grinding, size separation and classification, fluid flow and material handling, have been omitted.

There is lack of continuity in the order in which the subjects are treated. Chapter I discusses "Heat and Power" which is taken up again in Chapter IX under "Electric Heating." There is evidence that some parts of the book have been written hastily which may account for inexcusable grammatical errors and confusing terminology. For example, in the introduction, the terms "operation," "process," and "unit process" are used indiscriminately. "Unit process" is often employed where it is obvious that "unit operation" is meant. In the first chapter the reader is informed that "the principal liquid fuel is *petroleum* oil." A section of the chapter on drying is entitled "Deliquefaction" (*sic*) which is defined as the processes of dewatering such as evaporation, filtration, and drying. As a matter of fact there is no such word, and if there were, would it not be more logical to apply it to the change of state, liquid—solid?

The table of contents states that a chapter on materials of construction will discuss the chemical and physical properties of metals, alloys, wood and ceramic materials. A search of this chapter reveals that the data on wood in chemical engineering construction is limited to a single use of the word in the last paragraph in the statement "concrete tanks often are used for the crystallization of salts and for this purpose are more valuable than *wood* because the heat is lost more rapidly." From this mere and negative mention of wood in a discussion of materials of construction, the inexperienced reader would naturally conclude that wood has little use in chemical engineering industries which, of course, is not at all true.

The author's selection of subject matter for the book has brought in a number of chapters usually not found in a book dealing with the unit operations of chemical engineering. Such subjects as electrolysis, catalytic processes, cost and financing, and plant location, have been included at the expense of either entirely omitting at least six of the more important unit operations, or of unnecessarily limiting the treatment of others of equal importance. This reviewer would also question the inclusion of condensed steam tables in the appendix of such a textbook of principles.

In defense of Professor Olsen's book it must be admitted that many of these shortcomings are those usually resulting from collective authorship, especially in books written by men who have widely differing points of view, interests, and experiences. The strictest kind of editorial supervision is required to reduce them to a minimum. It requires an editor who not only has a thorough knowledge of all of the subjects treated but also has the fortitude to overhaul his collaborators' contributions to make them conform to the highest standards. The task is not an easy one.

This reviewer would not wish to leave the impression that this book does not have something to its credit. The chapters on flow of heat, evaporation, fractional distillation and gas absorption, although brief, are good. The chapter on steam distillation, although it trespasses somewhat on subjects treated elsewhere, is also to be commended. The treatise on catalytic processes contains much important information. The bibliography and problems in this chapter are excellent, but they emphasize, by contrast, the serious omission or inadequate scope of problems in several other chapters. The discussion of the separation of solids and liquids from gases merits special attention. From the standpoint of organization and clarity of presentation, it is a model. The selected bibliography with this chapter is the sort that should have been included in every chapter in the book. It is excellent. Chapters on cost and financing and plant location, although in the opinion of this reviewer out of place in a book on unit operations, are nevertheless well done and could be read with benefit by practicing chemical engineers as well as by students.

Carrying on for Ellwood Hendrick

Marvels of Modern Chemistry. By *Beverly L. Clarke*. Published by Harper & Brothers, New York. 374 pages. Price, $3.

Reviewed by *A. E. Buchanan, Jr.*

IN HIS FOREWORD to this volume, Dr. Clarke explains that it is intended as a modernized version of Ellwood Hendrick's "Everyman's Chemistry." In his later years, Dr. Hendrick recognized that the tremendous strides taken by science of chemistry in the past decade had somewhat antiquated his famous book of popularized chemistry

and had invited Dr. Clarke to collaborate with him in a revised edition. Unfortunately the genial Hendrick did not live to carry out the plan, so his co-author has undertaken to complete the work along the lines originally planned. The author begs that his work be not compared with its illustrious ancestor lest the "shortcomings" of the newer volume reflect on the memory of the old "maestro."

After such a graceful acknowledgment of the Hendrick influence and such an evident spirit of humility in attempting to assume the mantle of the late sage of Murray Hill, it would be unkind of the reviewer to allow a comparison between the styles of Hendrick and Clarke to flavor his evaluation. Yet a subconscious contrast is inevitable, for the reader of Clarke's book frequently stumbles upon Hendrickisms that recall immediately the burring, guttural voice and the whimsical conceptions of that king of chemical story-tellers. Thus, in the description of the historic experiment of forming iron sulphide by the direct union of the elements we read: "It is as if we were trying to pair off in matrimony a group of men and women. If there were in that group more of one sex than of the other, we should have that excess remaining as unappropriated blessings. The reason in this case is the law against bigamy. In the case of iron and sulphur it is the Law of Constant Proportions." Again, in the chapter on alipathic compounds, we find a typical Hendrickism: "Pyridene, which smells like stale tobacco smoke with remorse added to it, is often used for this purpose (denaturing alcohol). We have never heard of anyone with a craving for it." A favorite Hendrick story is retold in connection with Arrhenius' work on the ionization theory at Upsala where he announced his momentous discovery in the words: "Sir, I have arrived at an explanation of the irregularities of solutions"; to which the busy Herr Doktor replied absent-mindedly: "That is very interesting; good-day." And a little further along we meet the good Ghosh and remember how Hendrick loved the pun and how delighted he was when Prof. James Kendall deflated the Ghosh postulates.

The author himself would be the first to acknowledge that his presentation of popular chemistry lacks the spontaneity and sparkle of its predecessor. It could not be otherwise, for there was only one Hendrick. But it would be unfair indeed to judge Dr. Clarke's book on such a basis for it stands on its own merit as a careful, painstaking effort to encompass the whole realm of modern chemistry in a small volume and in language that everyone can understand. The author's scholarly attainments, not only in his specialty but in general cultural background as well, are clearly evident in his writing. Indeed, these attainments are probably his greatest handicap in presenting a treatise for popular consumption. Thus, his discussions on the laws of thermodynamics, the quantum theory, wave mechanics, etc., are, it is feared, somewhat over the head of "Everyman." Perhaps the author would have been wise to ignore the voice of his scientific conscience and to omit some of the subjects that are so difficult to summarize in words of one syllable. For instance, we can have nothing but admiration for Clarke's valiant effort to condense a complete course in qualitative analysis to 500 words. But at the same time, we can't help wondering why he completely omitted a discussion on a subject of such general popular interest as Cellophane, for instance.

Dr. Clarke's book is worth enough of anybody's time to read it. It will refresh the memories of those of us in the profession who have gravitated willy-nilly into a rut of specialization, and will provoke a keener appreciation of modern chemistry in the minds of readers who have not seen a chemistry book since their freshman year. This reviewer was especially pleased with Dr. Clarke's "definition" of chemistry: "It is a way of understanding things." Such a conception might well be used as a text by authors who aspire to impart their own enthusiasm for the science to the public.

More on Moving Materials

MODERN MATERIALS HANDLING. By *Simeon J. Koshkin*, Assistant Professor of Machine Design, Cornell University. Published by John Wiley & Sons, Inc., New York, 1932. Cloth, 6x9 in., 174 illustrations. 488 pages. Price, $6.

Reviewed by *G. L. Montgomery*

THE PREFACE of this work states that it is the outgrowth of a lecture course given for the past six years at Cornell University and is largely material supplied by the manufacturers of the equipment considered, supplemented by quotations from engineers and writers in the materials handling field. Because of this method of compilation, the book contains much that is of great value to the student and engineer. It suffers, however, from the lack of logical development inherent in the method of composition and is consequently much more useful as a reference work than as a textbook.

The first chapter, on "General Principles and Classifications," is well-presented and useful. Unfortunately, it is not related to the material in the remainder of the book and so it is difficult to use the principles set down for selecting a specific handling installation.

The book contains good descriptions of most of the types of materials handling equipment that are available. To this is added much helpful material on the applications of this equipment. The chief lack is the omission of any discussion of the engineering principles upon which the use of this equipment is based. In spite of these defects, however, this book is the most useful volume yet to appear in the slowly growing literature concerned with the movement of materials.

Gurwitsch in New Edition

THE SCIENTIFIC PRINCIPLES OF PETROLEUM TECHNOLOGY. By *Dr. Leo Gurwitsch and Harold Moore*. Published by D. Van Nostrand Co., Inc., New York. 571 pages. Price, $8.00.

Reviewed by *H. S. Bell*

THE "Scientific Principles of Petroleum Technology" by Dr. Leo Gurwitsch was first presented in English by Harold Moore in 1926. Subsequent to Dr. Gurwitsch's death, Mr. Moore prepared a new edition, bringing this standard work up to the present time.

The original text and arrangement are preserved and the new subject matter is interpolated in logical order. The new information covers late developments in all branches of petroleum technology. Of particular interest to American readers is the inclusion of data on American oils. The results of experiments and information on their physical and chemical properties are presented.

The sections upon manufacturing are revised to include the newer developments in pipe stills and cracking equipment. These sections are general and the application of processes to the desired results are not shown in detail. For instance, the relation of vapor phase cracking to anti-knock value of a motor fuel is not developed.

Of interest to electrical engineers as well as to petroleum technologists working with transformer and insulating oils, is the original presentation of power factor phenomena as affected by the characteristics of the oil.

Hydrogenation is briefly reviewed by a discussion of the Bergius process. A more thorough presentation of the reactions and commercial applications of this process would have been welcome in view of the wide-spread interest in hydrogenation.

The value of this book is primarily in the wealth of information upon the chemical and physical properties of crude oils and their derivatives and the scientific theories behind the different methods of refining. The information is conveyed concisely but competently.

Elements of Sanitation

THE SANITATION OF WATER SUPPLIES. By *Murray P. Horwood, Ph.D.* Charles C. Thomas, Springfield, Ill. 181 pages. Price, $3.50.

Reviewed by *Sheppard T. Powell*

SO MANY TEXTS on this subject have been released within recent years, that it is difficult to assemble many new

data, excepting by the recital of the author's personal experience and reporting of current developments in the art. Although specialists in this field will find little new material of interest in the text, the book contains much historical and current information which is valuable to elementary students for which the book is presumably intended. The text is divided into ten chapters. The first five chapters are devoted to a dissertation on the sources of supply, consumption and a comprehensive discussion of water-borne diseases. The remaining chapters cover a description of water purification from a purely academic viewpoint. "The Rise of Municipal Sanitation and Public Health" and "The Development of Municipal Water Supplies" are the most important chapters. The portion of the text relating to water as a vehicle of disease is an excellent and concise discussion of this problem.

Century of Progress Series

CHEMISTRY TRIUMPHANT. By *William J. Hale*. The Williams & Wilkins Co., Baltimore, Md. 151 pages. Price, $1.

ALTHOUGH THE study of chemistry, in one form or another, may be traced back to the days of antiquity, the true significance of its importance to all other natural sciences, and to the material prosperity of the race, has hardly dawned upon the public thought. The author, in his review of human history in chemical perspective, discusses present and future problems from the chemist's point of view, and elucidates the five interesting principles of what he calls "Chemeconomics."

OUR MINERAL CIVILIZATION. By *Thomas T. Read*. The Williams & Wilkins Co., Baltimore, Md. 165 pages. Price, $1.

THIS LITTLE volume describes interestingly the part metals and minerals have played in the progress of civilization and the development of the human race. Although treated in a popular manner, the subject is not without interest to the technical man, who will find much general information outside his specific field of activity.

DIE INDUSTRIELLE HERSTELLUNG VON WASSERSTOFF. By *Dr. Heinrich Pincass*. Verlag von Theodor Steinkopff. Dresden and Leipzig, Germany. 82 pages. Price, RM.7.30.

INDUSTRIAL PRODUCTION of hydrogen is dealt with in this volume. Among the processes described are, production from water gas; from coke-oven gas; from hydrocarbons; reduction of water with iron at elevated temperatures; the electrolytic process; various chemical methods, some of which are mainly academic in interest. A list of patents, a bibliography, and a discussion of economic features are also included.

Intelligible Relativity

THE RELATIVITY THEORY SIMPLIFIED (And the Formative Period of Its Inventor). By *Max Talmey*. Falcon Press, New York, 1932. 186 pages. Price, $1.50.

Reviewed by *T. R. Olive*

IN ADDITION to making a simplified presentation of the special and general relativity theories, Dr. Talmey has succeeded as no previous writer on the subject has done in humanizing Albert Einstein. The author knew him well in his youth and followed his subsequent career with evident care. It was, in fact, his interest in Einstein that caused him to study the development of the theory, for Dr. Talmey, although an amateur of great capabilities, is not a physicist at all, but a doctor of medicine. But despite the status of its author, the book is as useful for students and teachers of physics as for laymen, as Dr. G. B. Pegram, of Columbia, remarks in his introduction to the volume.

Dr. Talmey effectively explodes the often-quoted statement that but 12 men in the world are capable of understanding the theory. As he points out, mathematics cannot be avoided in the interpretation, but his book is proof of the fact that this need not be higher mathematics. There is not a differential nor an integral sign in the entire volume. With a little concentration it seems reasonable that any graduate in elementary algebra should be able to follow the simple steps whereby the author leads from the elementary conceptions of relative events, duration and length, to the more abstruse physics and gravitational fields and Gaussian coordinates. The book is recommended without qualification, both as a mental exercise and as an entertaining evening's reading.

INTRODUCTION TO METALLOGRAPHY. By *L. W. Eastwood*. Ann Arbor, Mich.: Edwards Brothers, Ltd. 137 pages. Price, $2.50—This book presents a thorough discussion of the general nature of metals and alloys, and their reaction to heat treatment and mechanical work. It also contains two appendices discussing laboratory methods for preparing and photographing polished specimens.

A COMPREHENSIVE TREATISE ON INORGANIC AND THEORETICAL CHEMISTRY. Vol. XII. By *J. W. Mellor*. London, England: Longmans, Green and Co. 944 pages. Price, $20—With the appearance of Vol. XII Dr. Mellor's excellent handbook is approaching completion. The present volume deals with uranium, manganese, masurium, rhenium, and iron.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Blown-Glass Tableware. U. S. Tariff Commission Report No. 60, Second Series: 10 cents.

The Cigar Industry and Tariff. U. S. Tariff Commission Report No. 62, Second Series; 5 cents.

Annual Report of the United States Tariff Commission, 1932; 15 cents.

Inks. Bureau of Standards, Circular No. 400; 10 cents. Outlines briefly the history of writing inks, gives formulas for several kinds, and general information.

A Study of the Pollution and Natural Purification of the Upper Mississippi River, by H. R. Crohurst. U. S. Public Health Service, Bulletin No. 203; 10 cents.

Profits From Cost Analysis in Paint Distribution, by S. L. Kedzierski. Bureau of Foreign and Domestic Commerce, Domestic Commerce Series No. 79; 5 cents.

Summary of Retail Distribution for the United States. Bureau of the Census; 20 cents.

Summary of Wholesale Distribution for the United States. Bureau of Census, Distribution No. W-151; 20 cents.

A Second Index of Patented Mothproofing Materials, by R. C. Roark. Insecticide Division, Bureau of Chemistry and Soils; mimeographed.

List of Publications of the U. S. Geological Survey, Department of the Interior. Revised November, 1932.

List of Publications of the Bureau of Mines, 1910-1932. Contains Subject Index.

Wages and Hours of Labor in Foundries and Machine Shops 1931. Bureau of Labor Statistics Bulletin No. 570; 10 cents.

Commerce Yearbook, 1932, Vol. II—Foreign Countries. Department of Commerce; $1.25. Elaborate statistical summary of world trade of foreign countries and other economic technical information. Vol. I, previously issued, related to the United States.

Deviation of Natural Gas From Boyle's Law, by T. W. Johnson and W. B. Berwald. Bureau of Mines, Technical Paper 539; 5 cents.

Silicosis and Tuberculosis Among Miners of the Tri-State District of Oklahoma, Kansas, and Missouri, for the Year Ended June 30, 1928, by R. R. Sayers and others. Bureau of Mines Technical Paper 545; 5 cents.

Mineral Production Statistics for 1931—Separate pamphlets from Bureau of Mines on: Magnesium and its Compounds, by P. M. Tyler, 5 cents; Clay, by O. E. Kiessling and K. V. Herlihy, 5 cents; Secondary Metals, by J. P. Dunlop, 5 cents; Sand and Gravel, by E. R. Phillips, 5 cents; Tin, by C. W. Merrill, 5 cents; Zinc, by E. W. Pehrson, 5 cents; Gypsum, by R. M. Santmyers and Jefferson Middleton, 5 cents.

Mineral Production Statistics for 1932—preliminary mimeographed statements from Bureau of Mines on: Bauxite; phosphate rock; sulphur; lime; pyrites.

The Leather Trade of the United Kingdom, by Walter B. Hertz. Bureau of Foreign and Domestic Commerce, Trade Information Bulletin No. 811; 5 cents. Contains notes on the general European leather situation.

PLANT NOTEBOOK

Nomographic Chart for Determining Heating Unit Design

By Temple C. Patton
Department of Physics
Massachusetts Institute of Technology
Cambridge, Mass.

A PROBLEM which frequently confronts the engineer is to construct a small heating element, using resistance wire as the heating medium. The choice of a proper resistance wire usually results in the selection of some chromium-nickel alloy. An alloy of 80 per cent nickel and 20 per cent chromium has been demonstrated to be first in desirable qualities for electrical heating elements which run at temperatures up to 2,100 deg. F.

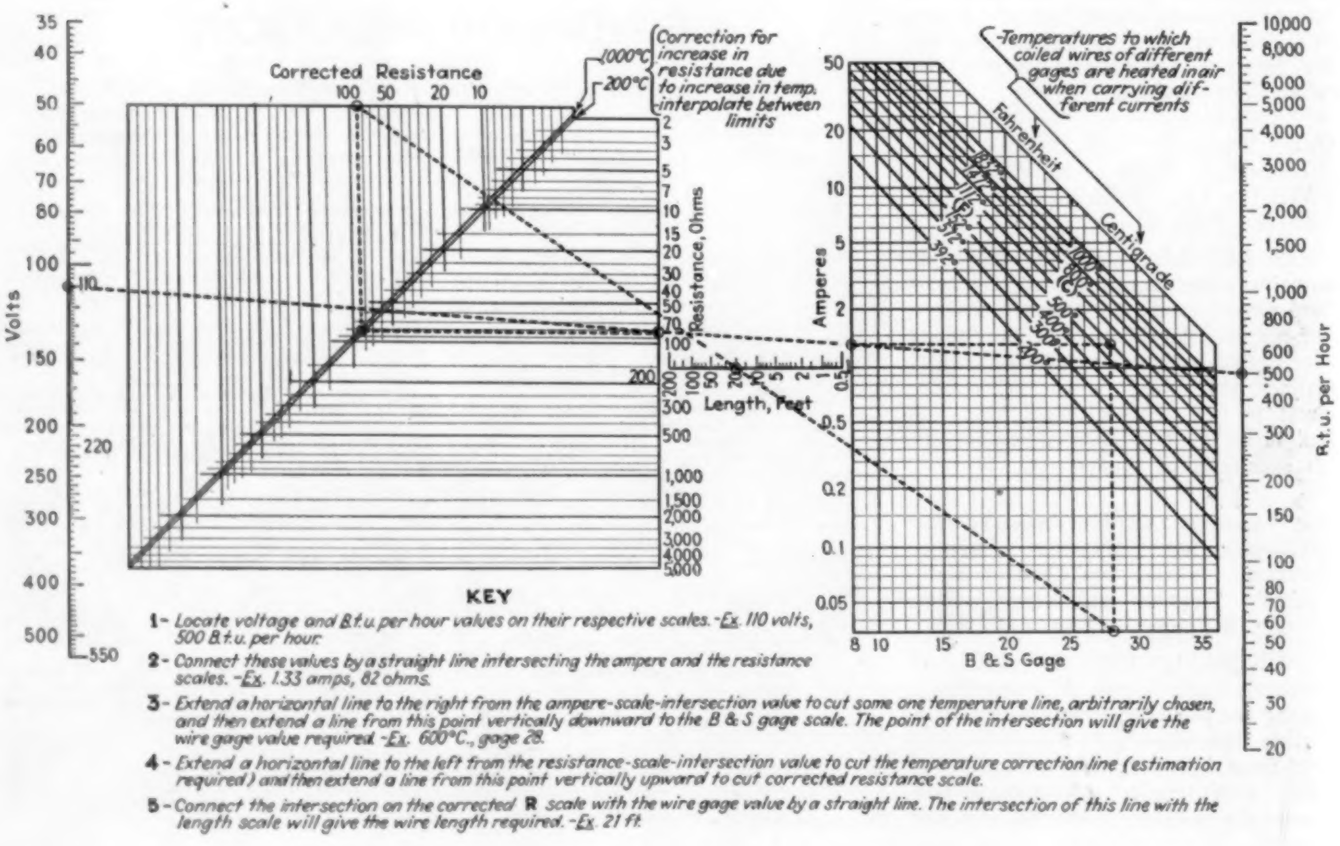
In designing a heating element, the engineer is usually influenced by two factors—the heat which must be evolved, and the line voltage available.

To meet these requisites of heat output and line voltage he controls the length and gage of wire used. For every choice of wire length, the gage is arbitrarily determined. The problem then reduces itself to the selection of the proper length or gage of wire. The controlling factor in this selection is the temperature attained by the wire when connected to the power supply line. If a wire of too small diameter is used, its temperature may reach its melting point.

For most heating units it is virtually impossible to determine with exactness a wire length or gage which will give just the wire temperature desired under operating conditions. Tables have been compiled, however, which give the amperes necessary to heat coiled wire of various gages to certain temperatures in air. Such tables serve also as a basis for estimates of wire temperatures under other conditions. Resistance wire when covered usually reaches a higher temperature, although this is not necessarily so.

Consequently, an inexperienced person may find considerable discrepancy between his prediction of the probable wire temperature and the actual wire temperature under operating conditions. It should be clearly understood that any factor which tends to dissipate heat at an increased rate allows a wire of corresponding smaller gage to be used.

The purpose of the accompanying chart is to provide an easy, quick, and accurate graphical method of determining the length and gage of wire required in a small heating element, in keeping with the discussion above. The method is divided into five convenient steps, four of which require the use of a



KEY

1 - *Locate voltage and B.t.u. per hour values on their respective scales. -Ex. 110 volts, 500 B.t.u. per hour.*

2 - *Connect these values by a straight line intersecting the ampere and the resistance scales. -Ex. 1.33 amps, 82 ohms.*

3 - *Extend a horizontal line to the right from the ampere-scale-intersection value to cut some one temperature line, arbitrarily chosen, and then extend a line from this point vertically downward to the B & S gage scale. The point of the intersection will give the wire gage value required. -Ex. 600°C., gage 28.*

4 - *Extend a horizontal line to the left from the resistance-scale-intersection value to cut the temperature correction line (estimation required) and then extend a line from this point vertically upward to cut corrected resistance scale.*

5 - *Connect the intersection on the corrected R scale with the wire gage value by a straight line. The intersection of this line with the length scale will give the wire length required. -Ex. 21 ft.*

straight edge. The chart key is noted on the chart, but a brief explanation of the solution is given here.

1. Locate voltage and B.t.u.-per-hour values on their respective scales. (Example: 110 volts, 500 B.t.u. per hour.)

2. Connect these values by a straight line intersecting the ampere and resistance scales. (Example: 1.33 amperes, 82 ohms.) It is important that a straight edge be used, as a bent or slightly curved edge will materially affect the accuracy of the solution.

3. Extend a horizontal line to the right from the ampere-scale-intersection value to cut some one temperature line arbitrarily chosen (Example: 600 deg. C.), and then extend a line vertically downward to the B & S gage scale. The point of intersection will give the wire gage value required. (Example: Gage 28.)

The choice of wire temperature is of course an arbitrary feature, and is subject to the limitations discussed previously. The wire gage value will be that nearest the point of intersection of the line extended vertically downward from the temperature line to the B & S gage scale. This value is one of the two necessary answers. Its location on the gage scale will be used in the fifth step to determine the wire length required.

4. Extend a horizontal line to the left from the resistance-scale-intersection value to cut the temperature correction line (estimation required), and then extend a line from this point vertically upward to the corrected-resistance-scale. The electrical resistance of wire increases with temperature. This effect, which is allowed for on the chart, is relatively small, amounting to only 7 per cent, at 2,000 deg. F. Consequently, only rough interpolation is necessary. The correction temperature is the predicted temperature at which the wire will operate.

5. Connect the intersection on the corrected resistance scale with the wire-gage value by a straight line. The intersection of this line with the length scale will give the wire length required. (Example: 21 ft.) This answer completes the solution of the problem.

One of the many advantages of the graphical solution is that the effect of a shift of some one value and its effect in changing values depending on it can be visibly seen. Thus, increased resistance due to increased temperature can be shown to be almost negligible, while an increase in line voltage from 110 volts to 220 volts completely changes the whole set-up.

It was mentioned in the beginning that the engineer is usually influenced by two factors, heat output and line voltage, in the design of a heating element, and the attending example was worked out on this basis. However, if any two factors, besides the operating wire temperature, are known, then by connecting these values according to the key (in reverse order if necessary) the other values can be obtained. Thus if wire of a certain gage, say gage 28, and a voltage of 110 volts are available, and assuming the wire is heated to 600 deg. C. in air (coil form), it will be shown by means of the chart that 21 ft. would be necessary and 500 B.t.u. per hour would be produced.

Air Conditioning Equipment Needs Corrosion Study

NO maintenance problem connected with air conditioning equipment is so little understood as the problem of corrosion. Speaking on the problem before the American Society of Heating and Ventilating Engineers at its Cincinnati meeting on Jan. 24, R. M. Palmer, of New York, found users of air conditioning equipment prone to criticise the manufacturer of the equipment for troubles which may arise and to hold the design of the equipment as being responsible. It is his belief, taking into consideration the advanced stage of development of air conditioning information, that the well-established and reputable manufacturers of air conditioning equipment are seldom responsible for difficulties encountered, such as rapid depreciation of equipment caused by the wear and tear of corrosion.

Corrosive Water Chief Trouble Maker

He went on to say that the chief cause for corrosion troubles is the use of a corrosive water in spray washers and condensers. The water in its original state may be corrosive. In any case, water used in spray washers, removes from the air washed, certain corrosive material.

Corrosive waters in forming rust on metallic surfaces bring about not only rapid depreciation, but much lower rates of heat transfer of metals corroded. It has been shown recently that the layer of rust produced on steel after a few months contact with a corrosive water, lowered the heat transfer rate of the steel in question to that of glass.

The constituents of the air, washed by the water, are invariably corrosive, to a greater or less degree. A corrosive gas which is invariably present in air washed is carbon dioxide. Carbon dioxide when absorbed by water forms carbonic acid, a weak acid it is true, but at the same time a corrosive acid. In the case of recirculated air which has been breathed by a relatively large number of people, the carbon dioxide content of the air may be high. In the case of air taken in from outdoors or from a plant, the air may be contaminated by gases produced by the burning of the various fuels, soft and hard coal, fuel oil, gasoline, etc. Some of these fuels carry a relatively high sulphur content.

Mr. Palmer had occasion recently to analyze a water which had been used for some time past in the spray washers of an expensive air conditioning plant. This water had never been analyzed previously. He found that this water was distinctly acid, having a pH of 6.5. The use of this water had made necessary the replacement of spray washer piping and pumps after six months' operation.

In another case it was necessary to analyze the water used in spray water of a new air conditioning plant, in this case the properties and analysis of the virgin water being used were well known. On the other hand, it had not been recognized that the air taken in from outdoors was at times badly contaminated with sulphuric acid mist arising from ventilating stack leading from a storage battery room. The absorption of this sulphuric acid mist by the spray water, produced a water of distinctly acid characteristics, which was distinctly corrosive. The fact that this problem was studied very early in the history of the operation of the air conditioning plant in question doubtless has resulted in the prevention of rapid depreciation of the equipment in question since remedial steps to correct the acid condition of the water have been taken and will be continued.

Water Replacement a Requisite

The practice of discarding water, used in spray washers, periodically, is an excellent one. Considerable amounts of insoluble matter accumulate in the spray washer and periodical removal of this material is certainly advisable.

In the foregoing connection, Mr. Palmer recently had occasion to analyze recirculated spray wash water and recirculated condenser water of two units operating in the same building, but controlled by different engineers. It was found that heat transfer efficiency of one of the units was considerably lower than the other. In the more efficient unit recirculated spray wash water and recirculated condenser water were discarded weekly, while in the other unit no fixed schedule for discarding water used had been followed.

In general it will be found that the analysis of water to be used in air conditioning equipment should be made prior to adopting it for use. If the proper attention is given to this problem, heavy replacement charges for corroded equipment may be avoided.

NEW EQUIPMENT

Dry Chemical Feeder • Magnetic Impurity Detector Automatic Underfeed Stoker • Centrifugal Mixer • Screen-Angle Indicator • Electric Trucks • Photoelectric Apparatus • Motorized Reducer • Flexible Wax • Rotary Piston Pumps • Solenoid Valve • Portable Draft Gage • Paper-Bag Packers • Improved Desuperheater • Improved Control Valve • Hydraulic Stoker • Differential Draft Control • New Type Flux • Manufacturers Latest Publications

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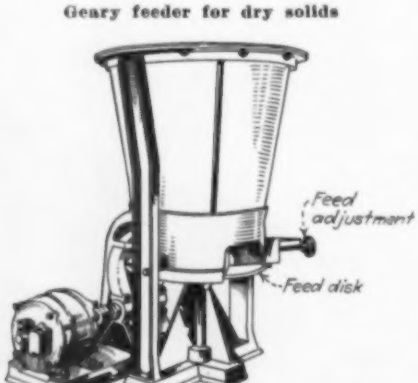
Dry Chemical Feeder

Developed especially for feeding diatomaceous earth, a new feeder introduced by the Galigher Co., 2238 South West Temple St., Salt Lake City, Utah, is said also to be effective in handling such materials as activated carbon, soda ash, alum, hydrated lime and other chemicals. The drawing shows the feeder to consist of a hopper in the bottom part of which is a rotating disk feeder driven by a small motor. Suspended inside the hopper is an anti-bridging device consisting of a fabric bag open at the bottom. The walls of the bag are kept in constant motion so that the material in the bag cannot "hang up" but must feed continuously. Discharge is effected by the rotation of the feed disk which carries a flexible rubber impeller to sweep material through a feed aperture. Feed emerges in a continuous stream under absolute control of the adjustable feed orifice.

Geary feeder for dry solids



Hopper capacity is 1 cu.ft. and maximum feed rate 40 oz. per minute.

Magnetic Impurity Detector

Magnetic impurities in asbestos, mica, glass, sand and similar materials are detected and their extent measured by a new magnetic device announced by the General Electric Co., Schenectady, N. Y. The detector consists of a differential permeameter and an indicating device. The former is essentially a coil for producing a high magnetic field for magnetizing the specimen, and two equal secondary coils for measuring the magnetic effect. The latter coils are placed in the magnetizing field and connected to the indicator with their induced voltages in opposition. The specimen is placed in one of the secondary coils, thus disturbing the electrical equality. The effect on the indicator is proportional to the quantity of magnetic impurities present.

Automatic Underfeed Stoker

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., has announced a new underfeed, screw stoker for boiler capacities from 10 to 250 boiler horsepower. The chrome-steel screw is driven by a variable-speed transmission through a safety shearing pin for overload protection. Automatic electric controls maintain predetermined boiler pressures.

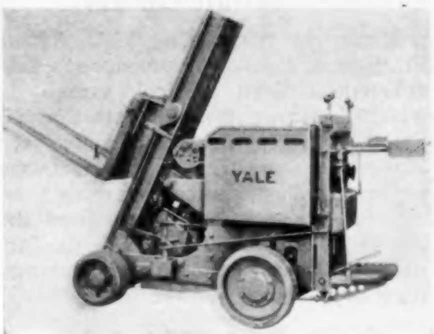
Centrifugal Mixer

Rapid and intensive operation, low power consumption, ease of operation, and small floor space, are said to be outstanding advantages of the Abbé Lenard mixer recently introduced by the Abbé Engineering Co., 50 Church St., New York City. As appears in the accompanying drawing, the mixer consists of two concentric cylinders, the inner one of which is slotted at intervals and supported above a mixing disk. The liquid or paste to be mixed, emulsified or dissolved is thrown outward by centrifugal force through a narrow aperture between the mixing disk and the inner cylinder. It is impelled upward by a powerful, spiral, circulating movement, thus disintegrating the material to a finely divided condition. The raised edges of the longitudinal slits in the inner cylinder are directed against the flow and the material passes through these openings and over the top into the mixing area. The disk then sucks the contents downward with great force and a continuous repetition of the movement takes place. These mixers are available in capacities from 1 to 220 gal., consuming from ½ to 10 hp.

Sectional view of paste and liquid mixer

Screen-Angle Indicator

To assist in the proper installation of its Universal vibrating screens, the Universal Vibrating Screen Co., Racine, Wis., has added to its late models a little device which has been named the "Angle-O-Meter." It is pointed out that the vibrating screen must be installed at the angle recommended by the manufacturer if power consumption is to be at a minimum. The Angle-O-Meter consists of a small pendulum suspended over a scale in such a way as to indicate immediately the exact angle at which the screen is installed.



High-lift tilting frame truck

Electric Lift Trucks

Yale & Towne Mfg. Co., Philadelphia Division, Philadelphia, Pa., has announced the development of three new lift trucks, a platform truck designated Model K26S10, a tilting frame truck called Model K31A and a high-lift, swinging-boom crane. The first has a capacity of 10,000 lb., the second of 4,000 to 6,000 lb. and the third of 1,200 lb. The lift truck has a 6-in. lift for the skid platforms on which it handles loads. The tilting truck can lift loads and tilt them backward as much as 25 deg. to insure safe traveling. The crane has a lift from 33 in. to 102 in. and an angle of boom swing of 90 deg.

Photoelectric Apparatus

Allied Engineering Institute, 98 Park Place, New York City, has announced the recent development of two new photoelectric meters which made use of Weston Photronic cells. One of these is a reflection meter for determining the total reflection of similar opaque materials, either in comparison with each other, or in comparison with a standard. Samples are illuminated by a parallel beam of light and the reflection viewed by two Photronic cells.

The second instrument is a color comparator and turbidity meter for measuring the total light transmission of similar colored liquids. The instrument functions as a wheatstone bridge, two arms of which are Photronic cells and the other two, adjustable resistances.

Motorized Reducer

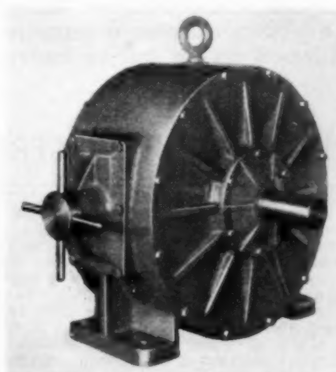
Under the trademark of "IXL Powered Gear," Foote Bros. Gear & Machine Co., 5301 South Western Blvd., Chicago, Ill., has introduced motorized speed reducers in sizes and types ranging from ½ to 150 hp. and ratios from 2:1 up to 3,600:1, for right angle, straight-line or offset drive, either horizontal or vertical. There are two general types, a worm-gear type with a special heat-radiating casing, and a helical-geared type. Anti-friction bearings are supplied regularly although sleeve bearings are optional.

Flexible Wax

Glyco Products Co., Bush Terminal Bldg. No. 5, Brooklyn, N. Y., has announced the introduction of "Emuwax," a new water-dispersible wax of great flexibility, light color and emulsifying properties. It disperses readily in hot water and is said to be more soluble in organic solvents than natural waxes. It is described as an emulsifier for oils and waxes. Its melting point is 115.8 deg. F.

Rotary Piston Pumps

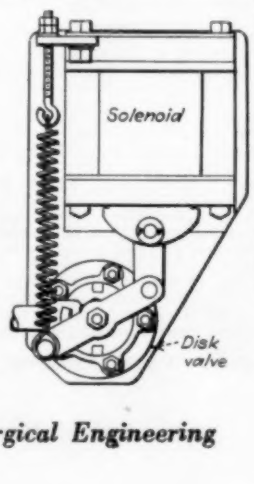
For pumping oil for hydraulic systems at pressures up to 4,000 lb. per sq.in., and capacities infinitely regulatable from zero to the maximum capacity of the pump, the Northern Pump Co., Minneapolis, Minn., has developed a line of rotary, radial-piston pumps in capacities from 1 to 150 g.p.m. Depending on size, these pumps have from three to nine pistons operating in a radial cylinder block placed eccentrically within a ring. Rotation of the cylinder block results in reciprocating motion of the pistons as shoes carried by the pistons slide in contact with the ring. The delivery may be varied by altering the eccentricity.



Rotary, radial-piston pump

Solenoid Valve

For the control of air, steam, oil, water, gas and other fluids, W. H. Nicholson & Co., 12 Oregon St., Wilkes - Barre, Pa., has developed a new line of solenoid-operated valves in two-, three- and four-way types. The valve is of the flat disk, regrinding type, the stem of which is sealed by a large stuffing box and a beveled shoulder seating against the body. The two-way is a straight-through valve used for "on" and "off" service. The three-way is used to operate single-acting; and the four-way, double-acting cylinders on all sorts of equipment. In the Model S-O type, the valve is opened when the current is on and exhausts when the current is off. In the model S-R type, a ratchet and rotary disk are used so that the solenoid is energized only momentarily to move the disk from one position to another.



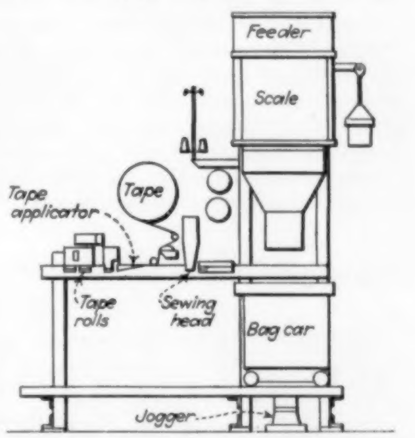
Model S-0 three-way valve

Portable Draft Gage

Using a slack leather diaphragm instead of a liquid-sealed manometer, the Hays Corp., Michigan City, Ind., has developed a new portable, pointer-indicating draft gage with graduations reading to 0.01 in., water gage. Among the advantages mentioned by the maker are: zero setting for the pointer, no leveling required, nothing to spill, easy portability, and light weight. This unit is also available for wall and flush mounting.

Paper-Bag Packers

A new line of automatic and semi-automatic machines for weighing, filling and closing bags has been introduced under the name of "Bagpacker" by Bagpak, Inc., 220 East 42d St., New York City. In cooperation with its affiliated companies, Consolidated Packing Machinery Corp., and Hoepner Automatic Scale Corp., the company has introduced four types, (a) a machine for automatically weighing, filling and closing bags; (b) a machine for automatically closing bags which have previously been filled on other types of equipment; (c) a hand machine for filling and closing; and (d) a hand machine for closing only. In the fully automatic machine two automatic scales feed into hoppers mounted on a revolving turret. The bags are carried on an agitated con-



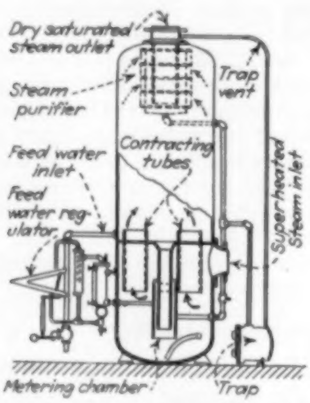
Type C Bagpaker for smaller capacities

veyor to assist in settling the material. When the bag is filled it is automatically passed through a sewing unit. After sewing, bags are sealed with a strip of paper tape.

The machine illustrated operates in a manner somewhat similar to the fully automatic machine, but it is for smaller capacity.

Improved Desuperheater

Combination in a single piece of apparatus of a desuperheater and a steam purifier has been announced by the Blaw-Knox Co., Pittsburgh, Pa. This consists of a Blaw-Knox "Contactor" combined with a "Tracyfier" (steam



Operating mechanism of desuperheater

purifier) and equipped with a standard make of boiler-feedwater regulator. The unit is shown in an accompanying illustration. It is stated to deliver dry, saturated steam, absolutely clean. In operation, a large supply of water is automatically forced into intimate contact with the steam insuring, it is said, complete elimination of superheat. Moving parts and spray nozzles are eliminated. It is claimed that fluctuation of quantity or quality of the steam or changes in steam pressure are immediately and automatically cared for, while impurities and mist are eliminated.

Improved Control Valve

To insure the accuracy of control by its instruments, the C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y., has developed a roller - bearing diaphragm valve in which friction is further reduced by decreasing the diameter of the spindle passing through the stuffing box. The valve is of the V-port, balanced type and diaphragms are available in diameters from $7\frac{1}{2}$ to $11\frac{1}{2}$ in.

Friction-free diaphragm valve

Hydraulic Stoker

Hydraulic operation of a new line of stokers for large heating or small power loads is announced by the Patterson Foundry & Machine Co., East Liverpool, Ohio. A small motor-driven rotary pump develops oil pressure which in turn operates the hydraulic ram piston which serves to feed the coal. Through the use of a regulating valve, any desired speed of the ram from zero to several cycles per minute may be obtained. The draft fan may be driven from the same motor that drives the pump or from a separate motor. The grate area is made up of sloping, slot-type tuyeres and slotted, side dump bars with a plenum chamber underneath, divided into zones for damper control.

Differential Draft Control

Mason Regulator Co., 1190 Adams St., Boston, Mass., has announced a new differential draft control system in which draft variations operate through a sensitive pilot device to control the blowers or dampers, so as to maintain perfect combustion under varying conditions. The instrument regulates the amount of air passing through the furnace in accordance with the natural draft of the stack and the fuel rate.

New Type Flux

Soldering of most of the commonly used metals except aluminum and its alloys is said to be readily accomplished through the use of a new flux, recently introduced by the American Chemical Paint Co., Ambler, Pa., under the name of "Flosol Cream." This has been developed for applications where the prevention of rust is of vital importance. A thin film of flux is applied like paint and neither runs nor spreads.

MANUFACTURERS' LATEST PUBLICATIONS

Ceramic. American Lava Corp., 1431 William St., Chattanooga, Tenn.—Leaflet presenting data on properties and uses of "Alsimag," a new acid- and heat-resistant ceramic formed by extrusion or pressing.

Chemicals. Grasselli Chemical Co., Cleveland, Ohio—30-page booklet listing this company's products, including chemicals, sprays, zinc and cadmium plating, with specifications for shipping containers.

Desuperheating. Blaw-Knox Co., Pittsburgh, Pa.—Bulletin 1417—4 pages describing this company's new line of desuperheaters.

Disintegration. Jeffrey Mfg. Co., Columbus, Ohio—Catalog 550—46 pages on this company's complete line of swing-hammer mills, pulverizers and crushers with capacities and other engineering data.

Dispersion. Chemicolloid Laboratories, Inc., 44 Whitehall St., New York City—4-page leaflet briefly listing applications of colloid mills in a number of industries as well as typical users of this company's mills.

Equipment. Foster Wheeler Corp., 165 Broadway, New York City—Loose-leaf general catalog on this company's equipment for refineries and power plants, including refinery equipment, steam generators and accessories, ash dischargers, pumps, condensers, heaters and evaporators, expansion joints, cooling towers and vacuum refrigeration equipment.

Furnaces. H. O. Swoboda, Inc., 3530 Forbes St., Oakland Station, Pittsburgh, Pa.—Bulletin 280—8 pages on continuous electric furnaces for heat-treating strip materials.

Furnace Regulation. Carrick Engineering Co., 410 S. Dearborn St., Chicago, Ill.—Catalog 100—12 pages describing the construction and use of this company's automatic furnace draft regulator.

Fumigation. American Cyanamid & Chemical Corp., 535 Fifth Ave., New York City—Leaflet 902—19 pages on the use of liquid HCN in industrial fumigation.

Humidity Control. Julien P. Friez & Sons, Baltimore, Md.—Bulletin B—4 pages on humidity control assemblies including humidistats and necessary relays; Bulletin D, leaflet describing this company's relative humidity indicator.

Linings. Stebbins Engineering & Mfg. Co., Watertown, N. Y.—Bulletin 1—6 pages describing this company's services in the installation of corrosion-resisting linings for industrial equipment.

Mechanical Rubber. Diamond Rubber Co., Cleveland, Ohio—24-page buyer's guide of mechanical rubber goods including belts, hose, tubing, packing and gaskets, and miscellaneous rubber goods.

Metals and Alloys. Foote Mineral Co., 1609 Summer St., Philadelphia, Pa.—Reprint of a 24-page article by J. H. DeBoer on the occurrence, preparation and uses of zirconium metal.

Metals and Alloys. Republic Steel Corp., Youngstown, Ohio—13-page book on Enduro stainless alloys, chiefly for architectural uses, with information on types, finishes, applications, fabrication data and installation methods.

Pipe. Republic Steel Corp., Youngstown, Ohio—6-page folder on this company's electric-welded drive pipe and casing for water wells.

Power Transmission. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1164—4 pages with descriptions and ratings on this company's line of motorized speed reducers.

Power Transmission. U. S. Electrical Manufacturing Co., Los Angeles, Calif.—Form 770—Describes this company's motorized speed reducers; Form 777, 4 pages on a new motorized variable-speed drive introduced by this company under the name of "Varidrive" motor.

Pulverizing. Raymond Bros. Impact Pulverizer Co., 1302 North Branch St., Chicago, Ill.—14 pages reviewing this company's pulverizing installations in 1932, with information on pulverizers, kiln mills and air separators.

Pumps. T. Shriver & Co., Harrison, N. J.—8-page booklet describing this company's diaphragm pump.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: Bulletin D-412-B2, forged-fluid-end, high-pressure power pumps; D-411-S1, magna pumps for viscous materials; W-313-S1A, 12-36 in. single-stage volute centrifugal pumps.

Rubber. B. F. Goodrich Rubber Co., Akron, Ohio—17-page reprint of an article on the chemical resistance of rubber as an engineering material, presented by Messrs. Fritz and Hoover before the A.S.T.M.

Temperature Control. Atlas Valve Co., 282 South St., Newark, N. J.—12 pages on "Victor" self-contained, vapor-type temperature regulators for liquids, including prices, hook-ups and engineering data.

Thermometers. Foxboro Co., Foxboro, Mass.—Bulletin 169-1—44 pages on recording thermometers, temperature controllers and accessories.

NEWS OF THE INDUSTRY

Federal action may establish use of alcohol in motor fuels. Patent litigation resulted in upholding process of Rustless Iron Corp., in sustaining charges of infringement against the city of Milwaukee in its sewage-treatment plant, and in declaring patents of British Celanese Co. invalid. Becket heads Mining Engineers for ensuing year

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Becket Elected President of Mining Engineers

AT THE annual meeting of the American Institute of Mining and Metallurgical Engineers held in New York Feb. 20-23 Frederick M. Becket, president of Union Carbide and Carbon Research Laboratories was elected president. He succeeds Scott Turner, director of U. S. Bureau of Mines, whose term had expired. W. H. Aldridge, president of Texas Gulf Sulphur Co. was awarded the William Lawrence Saunders Medal, given annually for distinguished achievement in mining engineering, and James O. Elton, manager of International Smelting Co., received the corresponding award in the metallurgical field, the James Douglas Medal. Dr. Georg Masing, the distinguished German metallurgist had been invited to give the annual Institute of Metals lecture. He had chosen as his subject: "Present-Day Problems in Theoretical Metallurgy."

Among the papers presented at the meeting were two on the latest developments in oxygen-free copper. Advantages of this product were thus summarized: It is definitely more homogeneous than ordinary copper, has greater ductility, and is almost immune to the reducing action of hydrogen at elevated temperatures. Tests conducted by an electric manufacturer show that fabricated articles of oxygen-free copper possess excellent physical properties, such as great resistance to twisting and bending.

The following conclusions were made in a paper on reduction of zinc ores with methane, a process that has been studied by metallurgists in the U. S. Bureau of Mines for the last three years: "Intense laboratory studies have demonstrated the possibility of solving the major difficulties involved. Unfortunately such steps are outside the budgetary limits of the Bureau. Under certain local conditions existing in this country, the economic advantages of the methane reduction process are so marked that it would seem justifiable to take such steps. In view of the extensive theoretical knowledge now available concerning the chemical problems involved, such a project should be less of a gamble than many other metallurgical wagers which in the end have proved successful. The odds on the process may conservatively be stated to be better than even."

Program Completed for A. C. S. Meeting

SEVENTEEN divisions, embracing practically every field of applied chemistry, will hold sessions at the eighty-fifth meeting of the American Chemical Society which will be held in Washington, D. C. during the week beginning March 26.

The sessions will open with a general program March 27, following a meeting of the directors. Speakers at this general session and their topics will include: Charles F. Kettering, chief engineer of the General Motors Corp., "The Relation of Chemistry to the Individual;" Harry L. Derby, president of the American Cyanamid Co., "The Relation of Chemistry to the State;" C. M. A. Stine, vice president of E. I. du Pont de Nemours & Co., Inc., "The Relation of Chemical to Other Industry"; Prof. Hugh S. Taylor, head of the Department of Chemistry, Princeton University, "Chemistry — Its Interrrelations With Other Sciences."

The Division of Industrial and Engineering Chemistry, of which Prof. D. B. Keyes of the University of Illinois is chairman, will hold a symposium on "Glass" in conjunction with the Glass Division of the American Ceramic Society.

The Division of Physical and Inorganic Chemistry, of which Prof. W. A. Noyes, Jr., of Brown University is chairman, will hold six sessions, including a symposium on "Electrolytes," under the chairmanship of Prof. V. K. LaMer of Columbia University.

The Division of Petroleum Chemistry, headed by F. W. Sullivan of Whiting, Ind., is arranging for two sessions, one being devoted to a symposium on "Properties of Hydrocarbon Mixtures."

A demonstration of dust explosions has been arranged by the Division of Chemical Engineering, Bureau of Chemistry and Soils for Thursday, March 30, at Arlington Farm. The demonstration, which will be in charge of D. J. Price, will show in miniature what takes place when organic dusts explode under various conditions met in industry and how the hazards from these dusts can be largely minimized.

Rustless Iron Corp. Wins Patent Suit

ON March 1, Judge William C. Coleman of the U. S. District Court at Baltimore, handed down a decision in favor of the Rustless Iron Corp. of America which was the defendant in a patent infringement action instituted in May, 1929 by the Electro Metallurgical Co. and the American Stainless Steel Co. The plaintiffs who are joint owners of the Clement patent and the Hamilton and Evans process patent claimed these patents were infringed in the manufacture of rustless iron by the Rustless Iron Corp. of America at its Baltimore plant. The decision of Judge Coleman held these patents to be invalid.

Legislation Proposed to Compel Use of Alcohol in Motor Fuel

PROPOSALS to compel, by legislation, the blending of alcohol with gasoline used as motor fuel in this country apparently has been changed from a State to a Federal proposition. Put forth as a farm relief measure calculated to absorb surplus farm products which might be converted into alcohol, the proposal was first taken up seriously in Iowa and quickly gained adherents in other mid-west corn-producing states.

Definite action on bills presented in the legislatures of Iowa and South Dakota was scheduled for the first week of March. Such action, however, was deferred apparently on the assumption, if not the assurance, that the question would be taken up promptly as a national issue.

While the original backers of the project were agricultural leaders, the possibility of legislative action in different states quickly drew the attention of industrial groups. Oil companies, alcohol producers, corn product manufacturers, and distributors of denaturants have been drawn into the picture.

Political controversies are numerous but cost estimates by responsible chemical engineers vary but little. Assuming the proposed corn price is arbitrarily fixed at the proposed 45 cents a bushel, makes 32 pounds of starch cost about 32 cents, if customary market credits are obtainable for byproduct corn oil and press cake. This starch would ferment to make 2.5 gallons of alcohol at a net materials cost of 13 cents per gallon. To be added are conversion charges for labor, minor materials, and capital; container and transportation expense; selling expense and overhead. Total estimated cost delivered to petroleum refineries is 24 cents per gallon of alcohol. Substituting this for 4 to 6 cent gasoline, present refinery cost at favorable locations, is estimated to mean a rise in the retail price of gasoline of about one-half cent a gallon, assuming no extra distributing costs are incurred.

Proposals of higher percentages of alcohol unquestionably will meet opposition on many scores. The petroleum industry will fight 10 per cent to the limit. Such mixtures require carburetor adjustments, certainly introduce corrosion troubles on storage containers and automobile parts, necessitate use of a third constituent for blending and increase the fuel cost to the user by several cents per gallon.

Present alcohol plants could make the requisite 300,000,000 gallons of alcohol for a 2 per cent national law with relatively small increase in capacity. At the present operating rates of 20 per cent, they are making about 75,000,000 gallons a year. New capital required would be for mash handling principally. It is estimated that a total outlay of $3,000,000 would place existing alcohol plants in a position to take care of the estimated increase in alcohol demand.

Since present plants could get into operation in 30 to 90 days for at least half the needed capacity, and within 6 months for the entire capacity, they would undoubtedly be handling the bulk of the business which they cared to do before any new plants could be designed and erected. However, it is reasonable to expect that some new plants would be built if there were any certainty of permanence of such legislation. It is a fair guess that the legislation might not be permanent on a compulsory basis. If so, new capital might well be timid when starting from scratch, though sufficient capital would quickly be available for plant remodelings.

The freight disadvantage of present plant locations is less than appears on the surface. Plants are at present located in California, Louisiana, Pennsylvania, Illinois, Indiana, Maryland, Massachusetts, New York, Kentucky, and New Jersey. It is evident, therefore, that alcohol production would be principally in the same states as gasoline production or major gasoline market.

Unquestionably, any legislation though having corn as its major objective would contemplate use of any other fermentable agricultural material available from domestic sources. Thus Louisiana sugar cane and Mid-West and Rocky Mountain beet byproducts undoubtedly would compete for a share of the business.

In discussing this question, *The Lamp,* organ of the Standard Oil Co. of New Jersey states that it is chemically and physically impossible to obtain a stable blend of 10 per cent commercial ethyl alcohol in gasoline without the addition of a blending agent, such as benzol or one of the higher alcohols.

It argues against the use of benzol as a blending agent from a cost consideration and referring directly to a proposed 10 per cent commercial alcohol blend it continues:

"The second argument against benzol is on the score of the quantity available. Taking a figure somewhere between the 1931 and 1932 domestic consumption of gasoline, let us suppose our motor fuel requirements to be in the neighborhood of 16 billion gallons. If this motor fuel were an alcohol-gasoline blend and not straight gasoline, as the proposals contemplate, we should need 1.6 billion gallons of ethyl alcohol and 3.2 billion gallons of benzol. As the greatest annual output of benzol in this country has never exceeded 100 million gallons, it is clear that a sufficient supply for any extensive adoption of the scheme could never be developed, even if there were no other markets for the product now."

Pulp and Paper Interests Will Meet in Savannah

IN RESPONSE to an invitation from the Georgia Forestry Association, a large number of pulp and paper mill executives, technical men, equipment manufacturers and superintendents are planning to examine at first hand, the prospects for development of the paper industry in the South.

A party is being organized to sail on Friday, April 28, from New York, arriving in Savannah, on Monday, May 1, to meet with the Georgia Forestry Association during its annual meeting. Return trips will be made on the following Wednesday and Friday.

The feature of the meeting will be to review the research work and to inspect the pulp and paper research mill of the Georgia Department of Geology and Forestry which is being operated under the direction of Dr. Charles H. Herty. The research activities are under the direct supervision of W. G. MacNaughton, formerly secretary of the Technical Association of the Pulp and Paper Industry, and of the manufacturing department of the International Paper Company.

Considerable work has been done in the study of the preparation of mechanical and sulphite pulp from the Southern pines. At the meeting on May 1 and 2 reports of this work will be given and papers will be read featuring the economic, engineering and other phases of Southern paper and pulp mill development. An opportunity will be provided for visiting forestation projects as well as naval stores plants.

M. I. T. Offers Course for Textile Research Work

An intensive six weeks' course in research for executives and research directors of textile mills will open at the Massachusetts Institute of Technology March 24. The course, specially designed for laboratory men, mill agents and overseers, will be Friday and Saturday of each week for a limited group. It will be jointly conducted by George B. Haven, professor of advanced machine design, and Edward R. Schwarz, assistant professor of textile technology.

NEWS FROM WASHINGTON

By PAUL WOOTON
Washington Correspondent of Chem. & Met.

SOME INFLATION of commodity prices, perhaps 10 per cent to 15 per cent, is inevitable. It is the objective deliberately sought by the new administration in its handling of the currency problem. The popular response came out of the psychological reaction to the bank holiday. Whether or not the gold standard has been repealed is an argument. Inflation is a fact. It may be only temporary but the question is whether the administration can control the situation if and when the exhilarating effect of the supply of federal reserve bank notes wears off.

The levity in the currency supply is matched by a levity of spirit imparted to the people by President Roosevelt. The new notes are his estimate of "adequate but sound currency" but there is a rather amusing, contrary disposition by the public to regard them as nothing but greenbacks. If they demand more this may be embarrassing. Apprehension of the effects of such a state of mind is the root of the conservatism of Carter Glass and Bernard M. Baruch. Their dismissal from Roosevelt's circle of advisers was of profound significance. The President refused to subscribe to their conviction that inflation, once started, cannot be controlled. The President himself dislikes to hear his method described as "controlled inflation." A definition may not be needed. Time will determine the fact.

Federal regulation threatens to overtake the pipe lines just as they are demonstrating their utility for transporting a variety of petroleum products other than crude oil. It is too soon to determine whether such regulation would interfere with the technical development but the inherent tendency of regulation is to restrain rather than promote. This may be the effect if the government simply insists that the pipe lines perform the function of common carriers.

Walter M. W. Splawn, special counsel of the House Committee on Interstate Commerce, agrees with practically everybody else that divorce of the pipe lines from the oil industry is not practicable but on his recommendation the committee has urged the Interstate Commerce Commission to consider whether it can exercise its statutory jurisdiction over oil pipe line rates to require pipe line companies to furnish both transportation and storage to small producers at reasonable rates. Pipe line tariffs, in general, are designed to exclude shipment of any except the products of the company which owns the line.

Regulation of interstate gas pipe lines also is embraced by the committee's recommendations. Dr. Splawn invites attention to the desirability of requiring certificates authorizing construction, and of fixing fair rates for gas delivered at city gates for local distribution. Appropriate legislation will be sought in the extra session or December session, whenever the House committee is organized.

Bitter complaint is heard that customs officials are not imbued with a proper deal in enforcing the anti-dumping law. Domestic industries should pick their quarrel with Congress. Dumping is narrowly defined in the present law. It cannot be stretched to include protection against depreciation of foreign currencies. Findings must be based on evidence. The Bureau of Customs has failed to find evidence of dumping of sulphate of ammonia from Holland and terpineol from Germany. Investigation of alleged dumping of sulphate of ammonia from Canada, Japan and Manchuria is still under way.

By direction of the Senate, the Tariff Commission has undertaken a general investigation of costs and competitive conditions relating to the importation of pulp timber, pulpwood and mechanical and chemical wood pulp from Canada, Sweden, Finland and Norway. The commission will report back to the Senate. It has no rate-fixing jurisdiction over free list items.

A reduction of 10c. to 5c. per gallon in the duty on crude sperm oil and of 6c. to 3½c. per lb. on spermaceti wax will take effect on April 1, by proclamation following an investigation by the Tariff Commission. The duty of 14c. per gallon on refined sperm oil was not changed.

Significant in the annals of chemical invention is the affirmation by the U. S. Supreme Court of the validity of the Weizmann patent for the production of acetone and alcohol by bacteriological processes. The Union Solvents Corporation, which was sued for infringement by the Butacet Corp. and Commercial Solvents Corp., contended that the Weizmann process is merely a statement of the result attained by permitting bacteria to perform their natural functions. The lower courts held that Weizmann's discovery was patentable as a fermentation process employing bacteria and the Supreme Court denied March 4 the Union Solvents Corp. petition for review.

Blending alcohol with gasoline as a motor fuel has political as well as technical complications. This explains the apparent attempt of the oil industry to shift the scene of battle from the legislatures of farm states, that presumably would benefit, to Congress, where the chance of defeating it is better. Farm organizations have enforced their will on Congress on various occasions but this proposal, necessarily involving a direct increase in cost to consumers is likely to meet opposition from the states with large urban populations. Any focusing of attention on federal legislation also would set up conflicts between states with competing supplies of products for the still. Louisiana's blackstrap won't be willing to give the corn belt a handicap.

The oil industry has learned not to expect much consideration from Congress but supposing that compulsory legislation can't be avoided, one law imposing uniform requirements is preferable to several diverse state statutes. The move for a federal law has lagged behind the agitation in South Dakota, Iowa, Illinois, Minnesota and other states but has sufficient momentum to bring it forward in the new Congress after the major legislative program gets under way. James M. Doran, of the Bureau of Industrial Alcohol, has prepared a report on the technical aspects of the subject for President Roosevelt, following a cooperative investigation with Standard of Indiana. A surmise that Commissioner Doran is sympathetically inclined to the proposal probably would be correct as administration of a federal statute undoubtedly would be placed in his bureau.

Operation of Muscle Shoals by the Bureau of Reclamation is being urged in the event the Norris bill is approved. It is pointed out that the Bureau of Reclamation has been constructing and operating hydroelectric plants for 25 years. It is the only federal bureau that has operated such plants commercially and done it on a paying basis and without controversy with the consumers who were municipalities, farmers, mining companies, and other corporations.

Leasing provisions have been eliminated. The government would engage directly in the manufacture and sale of power and fertilizer. The bill carries an appropriation of $10,000,000 for modernization of Muscle Shoals and construction of Cove Creek dam. The bill also includes provisions authorizing surveys of the Tennessee River Valley and directing the President to submit to Congress his recommendations for specific projects as the surveys progress.

NEWS FROM ABOARD

By Special Correspondents of Chem. & Met. at London, Berlin and Paris

London

THERE is reason to think that this country and particularly British chemical industry will get through the winter with less hardships than seemed probable and that the normal revival in the spring will not only be pronounced, but the forerunner of better times. Production costs have clearly been lowered and the effect of tariffs is only just beginning to make itself felt. Certainly the annual reports of the larger industrial companies, and even the chairmens' speeches of those ultra-conservative institutions, the British banks, are surprisingly optimistic. The various scientific and technical societies and institutions have also weathered the economic adversity successfully, reduction in membership being slight, and yet sufficient to prevent any energetic departure from the normal routine existence into which too many have drifted.

The new Food and Plastics groups of the Society of Chemical Industry have been an instantaneous success. Among the new vice-presidents of the Institution of Chemical Engineers, the name of Dr. Herbert Levinstein will be noted with interest by his many friends in the United States.

Judgment was delivered on Feb. 13 in the action for infringement brought by British Celanese against Courtaulds, and fully confirmed the views given in these notes last December. In the result all three patents upon which the Celanese company relied were ordered to be revoked, and it was held that infringement had not been established. The action, which aroused very great interest in industrial and financial circles, lasted thirty-five days and towards the close some very interesting evidence was given by Prof. Ernst Berl, now professor at Darmstadt and formerly chief chemist of the Tubize Rayon Co. Justice Clauson held that the downward spinning patent told the world nothing it did not know before, and in the absence of subject matter was invalid. As regards cap spinning and lubrication, this was held to have been anticipated in analogous uses and industry, and here again there was lack of subject matter as well as absence of infringement. The third patent elicited some rather scathing comment, and according to the judge must be regarded as nothing more than an obvious piece of reasoning, which told the world that if you kept your conditions of spinning and production uniform, you would get a uniform result, and that was merely the enunciation of a truism.

There is renewed activity in processes for the coloring and protection of metals and the rustproofing of iron. Processes such as "Nust" which rely on lead, and others depending upon phosphorus compounds have been developed both here and in Germany, the processes of the I.G. and a liquid paint known as "Edgerol" having entered various markets to supplement the known parkerizing and bonderizing methods so successfully used by the automobile industry.

Iron and steel parts are now being colored and protected direct by immersion in chemical solutions with deposition of metal oxides, and very beautiful colors are being produced by Metal Processes, Ltd. Similar but even more beautiful and iridescent effects have now been produced on the zinc film present on galvanized iron sheet, and it is claimed that these coatings will withstand the action of the weather and even tropical conditions satisfactorily, and thereby obviate the necessity of applying paint to galvanized roofings, such paint as is known being liable to peel and requiring frequent renewal. The cost of this treatment is said to be about 15 per cent of the cost of the galvanized sheet. As regards aluminum there is now a factory under construction to produce dyed and colored protected surfaces similar to those of the American "Alumilite." An interesting paper was presented to the Chemical Engineering Group last month on corrosion research, at which these matters were discussed in detail, and special reference made to the use of selenides and "Panalumin" solutions for protecting magnesium alloys.

Paris

THE GENERAL situation continues to be unfavorable; a slight tendency toward improvement which manifested itself toward the end of last year has not continued. As a result the number of unemployed persons officially enrolled which heretofore had not reached 300,000 has just exceeded that figure.

As to what concerns the chemical industry more especially, we find that it is rather fortunate in having undergone altogether a total loss less than metallurgy and the industries associated with it. It is interesting in this connection to note that in France chemical industry comprises about 1,100 separate enterprises employing approximately 200,000 workmen and a staff of from 4,000 to 5,000 engineers and chemists. The capital invested reached the figure of 15,000,000,000 francs in 1930 and the production value for this same year was 11,400,000,000 francs. Since then it has steadily dropped to 9,000,000,000 francs in 1931 and can be estimated at about 8,500,000,000 for the fiscal year 1932; this figure constitutes a drop of about 30 per cent from the record figure of 1929 when the production was estimated at 12,000,000,000 francs.

The figure of actual business does not make it possible to judge the financial yield of the fiscal year 1932 for which there are still no accurate figures. Nevertheless from the fact that most companies failed to pay the January dividend, it can be concluded that generally speaking, the dividend will be lower, with an exception made for certain concerns, although no definite facts will be known until April or May.

Recently there was celebrated by the Civil Engineering Society of France the fiftieth anniversary of the basic processes of dephosphorizing steel by Thomas and Gilchrist, a process which has made for considerable development in phosphorous-bearing minerals and more especially the minette ores of Lorraine. Indeed, of the 9,447,000 tons of steel produced in France in 1930, 98 per cent was obtained from the basic process, which permitted procuring as byproducts of nearly 1,500,000 tons of Thomas phosphate slag.

Berlin

THE LARGEST suspended electric sign in the world, a 72-meter Bayer cross, visible for 7 miles, has recently been placed at the Leverkusen plant of I. G. Farbenindustrie. The entire network for 2,200 lamps has been made from rust-free wire, and is fastened to the two 126-meter stacks. At the inauguration of this sign, Consul R. W. Mann, head of Verkaufsgemeinschaft Pharmaceutika (pharmaceutical sales association) stressed the importance of Leverkusen and of the German pharmaceutical production of which about 70 per cent is exported; about 100,000 men are employed by this industry.

The recently established "Deutsche Erdolverband" (German petroleum as-

sociation) is not a combine of all German petroleum producers, but a group of land owners who have decided to apply for funds set aside by the government for creating employment.

The number of methods for production of sugar from wood which have been frequently discussed (Bergius and Scholler-Tornesch processes) has been further increased by a new interesting procedure by Prof. Fredenhagen and G. Cadenbach. It is based upon the circumstance that hydrofluoric acid, free from water, dissolves large amounts of cellulose in a clear, colorless solution. Iron apparatus cannot be used in the process. Dissolution is affected by conducting gaseous hydrofluoric acid at regular temperature over sufficiently small, dried wood, in which it is absorbed. The acid may to a larger extent be recovered from the material by suction or by blowing with air. By the action of the acid the material shrinks to a brittle cake, which is easy to break up. Extraction of the treated material is facilitated by leaving a small amount of hydrofluoric acid, sufficient to make the wash water slightly acid, whereby dissolution of the sugar (polyglucosan) is increased. Acid is removed by precipitation with calcium carbonate, and wood sugar is recovered by evaporation in vacuum. The product may be used for technical purposes or as cattle feed, or it may be converted into glucose and used in regular manner (D.R.P. 560,535).

A new diffusion method for manufacturing transparent hot-vulcanized dipped articles from latex concentrates is described by the well-known rubber expert Dr. R. Dittmar, Graz. Jatex, a concentrate obtained by centrifuging latex (E.P. 219,635, 1923) which after evaporation to 40 per cent gives a film as clear as glass, is used as dipping fluid. The articles are dipped at 40 deg. C. followed by vulcanization in a bath made by dissolving 100 grams or more of the finest sulphur in 1000 c.c. benzol. Part of the sulphur remains on the bottom of the vessel and maintains saturated solution when the temperature goes up, and as sulphur is taken up during the vulcanization process. To promote the reaction is used an addition of 20 grams Vulcafor ZDC (zinc di-ethylene carbamate). A dip from 6 to 12 sec. in this solution is used, followed by vulcanization for 30-40 min. at 122 deg. C. This procedure eliminates the mixing and dissolving apparatus, and the arrangement for regeneration of gasoline, required in the hot-vulcanization in gasoline solutions. The use of Jatex and the elimination of added activators and protective colloids result in a perfectly transparent film of extra long life.

Light-metal flasks for gas of high compression, made from alloys with a specific gravity about a third of that of steel, and which equal Siemens-Martin Steel in tensile strength and elasticity, are produced by Rheinische Metallwaren u. Maschinenfabrik, Düsseldorf. Flasks of 0.8 to 5 liters' capacity and capable of standing 150 atm. operating pressure (225 atm. test pressure) are used for portable ozygen breathing apparatus, and for carbon dioxide and compressed air in aviation. Flasks with a capacity of 18 liters (largest diameter 152 min.) are also made. Saving in weight is about 50 per cent.

In ordinary mercerizing methods the cotton, after a treatment by boiling, is dipped in a bath containing 20 per cent sodium hydroxide and left for a few minutes. Attempts have been made to eliminate the time- and heat-consuming boiling by giving the cotton a preliminary treatment in turkey red oil, or by suitable additions to the sodium hydroxide bath, additions which might increase the action of the hydroxide on the cotton.

"Buy American" Motivates Ceramists at Pittsburgh

CERAMISTS of the American Ceramic Society actively joined the "Buy American" movement in Pittsburgh during the society's 35th annual meeting which was held during the six days, Feb. 12-17. Somewhat subordinated in interest to the society's attempts at the development of a nationalistic spirit on the part of buyers of ceramic wares were the programs on research, the phase rule in ceramics and "Electrons at Work and Play." An important feature was the initiation of a comprehensive series of papers by the materials and equipment division which heretofore had limited its meeting activities largely to social events. Generally considered an outstanding feature of the week was this division's demonstration of a new method for the high-speed cutting of porcelain, glass and other ceramic wares, using a lathe and silicon carbide tool.

Symposiums held the attention of three divisions. Enamelists discussed gas defects at length while the refractories group treated similarly the physical chemistry of alumina-silica refractories, and the white wares division presented a symposium on plant practice. Although not so labeled, the structural clay products division's interest in the de-airing of clays approached symposium proportions.

Officers selected for the following year included John C. Hostetter, director of development of the Corning Glass Works, who was elected president; L. J. Trostel of Baltimore, Md., was elected vice-president; and H. B. Henderson and Ross C. Purdy, who were re-elected treasurer and general secretary, respectively.

Sewage-Treatment Patents Infringed in Milwaukee

IN A decision given on Feb. 7 by Judge F. A. Geiger of the U. S. District Court in Milwaukee, the city of Milwaukee was held to have infringed sewage-treatment patents owned by Activated Sludge, Inc. The original patents were issued to Walter Jones of Jones and Attwood, Ltd., England. American patents were granted, two in 1917, one in 1918, and one in 1921. The claims of the original patent, filed in England in 1913, cover the process of aerating sewage by introducing air through porous bodies in the bottom of a tank in such a way as to cause circulation of the sewage. The second patent covers the apparatus for accomplishing such aeration. The introduction of sludge into the sewage during aeration and re-aeration of the sludge are covered by the claims of the third and fourth patents.

The defense rested largely on the contention that the patents were invalid because independent and earlier invention should be ascribed to Harry W. Clark at the Lawrence Experiment Station and to Harrison P. Eddy at Worcester, Mass.

Experimental work on sewage treatment was begun in Milwaukee in 1914. By the end of 1917 it was decided that the activated-sludge process was best adapted to the city's needs. The plant using that process was put into operation in 1925.

The case has still to be heard in a court of claims for the assessment of judgment with the expectation that the city will appeal the case to the Circuit Court of Appeal.

New Edition of Canadian Chemical Directory

A NEW Directory of Chemical Industries in Canada has been published by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa. It is divided into two parts. Part One contains an alphabetical list of manufacturers showing the head office addresses, plant locations and detailed lists of products. Part Two consists of an alphabetical list of commodities with the names of the producers in each case.

As in previous issues, the directory has not been limited to actual producers of chemicals in the strict sense of that word but has been extended to include the manufacturers which use chemical processes or make related products of interest to the chemical industry in general. Pulp and paper mills, leather tanneries, breweries, distilleries, petroleum refineries, sugar factories, and all other such plants are included.

Names in the News

George Oliver Curme, Jr., will be awarded the Chandler Medal for 1933 on March 17 at Columbia University. The award goes to Dr. Curme for his achievements in aliphatic chemistry. Dean Howard Lee McBains of the Columbia graduate faculties will preside.

E. H. Volwiler, research director of the Abbott Laboratories, Chicago, Ill., has been elevated to the position of vice-president of the company.

Walter M. Mitchell, formerly with the Republic Steel Corp., is now connected with the stainless alloys committee of the U. S. Steel Corp., New York City.

C. I. Post has been appointed manager of the Vitex department of the National Oil Products Co., Harrison, N. J.

A. H. Jenkins is chief chemist for Uralvagonstroi, the railroad car factory at Nizhni Tagil, Russia.

Irving Langmuir, who received the Nobel Prize for outstanding achievements in chemistry in 1932, has returned to his office in the General Electric Laboratories, Schenectady, N. Y.

John C. Hostetter, since 1930 director of development and research for the Corning Glass Works, has been elected president of the American Ceramic Society for the coming year. Mr. Hostetter has been connected with Corning since 1919, prior to which he was engaged in work on glass with the Bureau of Standards, Geophysical Laboratories and the War Industries Board.

Ralph T. Goodwin, formerly with the Dorr Co., Inc., has been made manager of the fuel oil sales department of the Shell Petroleum Corp. Dr. Goodwin is located at St. Louis, Mo.

Harold Schroeder, chemist for the Dixie Mercerizing Co., was elected chairman of the South-Central section of the American Association of Textile Chemists at the recent annual meeting. The other officers elected were L. E. Milliken, Homer Welchel and Andrew J. Kelly.

Earle E. Langeland is now associated as chemist with the Union Paste Co. of Medford, Mass.

Samuel N. Spring has been appointed dean of the New York State College of Forestry at Syracuse. Dean Spring, who has been assistant dean of the college, succeeds Dr. H. T. Baker who left Feb. 1 to assume the presidency of the Massachusetts State College at Amherst.

George Oliver Curme, Jr.

O. B. J. Fraser, formerly in charge of the research laboratory of the International Nickel Co. at Bayonne, N. J., is now located in the development and research department at the company's main offices in New York. He will be in charge of developments in the applications of nickel and its alloys in the oil, gas and coke industries.

Norman B. Pilling, formerly in charge of metallurgical research of the International Nickel Co. has been placed in charge of the research laboratory. E. M. Wise, whose work heretofore has been largely associated with precious metals, has been appointed assistant to Dr. Pilling.

Warren C. Bruce, formerly chemical engineer with the Barnsdall Tripoli Co. has entered consulting work in chemical engineering with headquarters in St. Louis, Mo. He is specializing in the application of chemical engineering to the materials and methods of construction.

John V. N. Dorr, president of the Dorr Co., New York City, has been elected to the Engineering Foundation Board.

Franklin W. Lane, until recently connected with the research laboratory of the Dorr Co., is now engaged in research work at the Krebs Pigment Co., Newport, Del.

R. B. Stringfield, consultant and manufacturer of molded rubber and resinous products in Los Angeles, Calif., is to have charge of the work in chemical engineering at the University of Southern California. Stringfield is a graduate of this institution, has carried on graduate work at M. I. T. and was with the Goodyear company for some years. His work at U. S. C. will be carried on in addition to his other activities.

Allen Abrams, Marathon Paper Mills Co., Rothchild, Wis., was reelected president of the Technical Association of the Pulp and Paper Industry at the annual meeting. C. C. Heritage, Oxford Paper Co., Rumford, Me., and R. G. Macdonald were reelected vice-president and secretary respectively.

H. R. Murdock, Champion Fibre Co., Canton, N. C.; E. O. Reed, Crane and Co., Dalton, Mass.; Otto Kress, Institute of Paper Chemistry, Appleton, Wis.; and W. R. Maull, Dill and Collins, Inc., Philadelphia, Pa., were elected to the executive committee of T.A.P.P.I.

T. M. Barry, formerly assistant general superintendent of Fraser Paper Ltd., Madawaska, Me., has been appointed to the position of assistant to the president of Fraser Companies, Ltd., at Edmunston, N. B.

W. S. Landis, vice-president of American Cyanamid Co., who has been on a several weeks business trip in Europe is expected to return to his office in New York in a few days.

John Calder has resigned after serving for 23 years as superintendent of the Wrenn Paper Co., Middletown, Ohio. He came to this country in 1889 from Scotland where he had been employed by A. Cowan and Sons, Inc.

A. R. Goldsby has entered the service of the National Aluminate Corp. of Chicago, Ill.

Nelson W. Taylor, assistant professor of physical chemistry, University of Minnesota, has been appointed professor of ceramics at Pennsylvania State College. Dr. Taylor expects to take up his teaching duties Feb. 1.

C. O. Henke of the E. I. duPont de Nemours Co., has been transferred from its Carrolville plant to the Jackson Laboratories at Deepwater Point, N. J.

F. W. L. Tydeman, head of the manufacturing department of the Shell Petroleum Corp., has been transferred to the Shell Development Co. at San Francisco, Calif.

Frederick W. Gest, research chemist, Virginia-Carolina Chemical Corp., Richmond, Va., has severed his connection after ten years of continuous service. During the past four years Dr. Gest has served as chief chemist.

OBITUARY

George P. Adamson, founder and president of the Baker and Adamson Chemical Works, which was absorbed by the General Chemical Co. in 1910, died Feb. 16 at his home in Searsport, Me. He was 68 years old. Mr. Adamson graduated from Lafayette College in 1884 with the degree of B.S. Three years later he received his M.S. degree, from the same institute. Shortly after graduating he founded the fine chemical reagent manufacturing business of Baker and Adamson. At the time his company was taken over by the General Chemical Co. he became chief chemist and director of research of the larger organization. Mr. Adamson retired in 1927. He was a charter member of the American Institute of Chemical Engineers.

George P. Adamson

All who knew him enjoyed his gruff, good humor, his friendly counsel, and, above all his willingness to do his share in carrying on the important work of the profession. He was chairman of the board of trustees that directed the publication of the International Critical Tables. He has long served as one of the elder statesmen in the privy councils of the chemical societies. He will be missed by all of us but his memory will long continue to stimulate unselfish service to the profession.—S. D. Kirkpatrick.

Richard A. Kipp, assistant chief of the technical division of the U. S. Bureau of Industrial Alcohol, died Feb. 21 at his home in New York City.

John Cupples, former manager of the wax refining plant of the Tidewater Oil Co., died Feb. 6 of a heart attack at Airdrie, Scotland. He was a resident of Bayonne, N. J. Mr. Cupples was 88 years old.

Benjamin B. Thayer, first vice-president of Anaconda Copper Mining Co., president of Raritan Copper Works, International Lead Refining, and Electrolytic Zinc Process Co., died at New York City on Feb. 22, at the age of 70. Mr. Thayer was graduated from the Lawrence Scientific School of Harvard University in 1885, and gained his practical experience in the West. He served on the Naval Consultation Board during the War, and was president of the A.I.M.E., 1914-15, and of the Engineer's Club, New York, 1925-26.

Anthony P. Sauer, president of the Seaboard Refining Co., died at his home in New Orleans, La., on Feb. 28. He was 81 years old. Mr. Sauer had been a leader in the cottonseed oil industry for 50 years.

George Gardner who had been associated in business with his father, F. E. Gardner, president of the Gardner Chemical Laboratories, Chicago, Ill., died of a heart attack on Feb. 28. He was 36 years old.

John Thomas, managing director of the dyestuffs group of the Imperial Chemical Industries, Ltd., died unexpectedly Feb. 4 in London, England. He was 46 years of age. Dr. Thomas was a pioneer in the British vat dye manufacturing industry. In 1918 he joined James Morton, who had established Scottish Dyes, Ltd., to undertake the experimental manufacture of the fast dyes of the anthraquinone type. In this field he discovered a number of dyes. In 1923 he became managing director of Scottish Dyes, Ltd., the latter becoming a part of I.C.I. in 1929.

Samuel J. Lamont, retired superintendent of the Linden, N. J., plant of the Grasselli Chemical Co., died Feb. 21 at Elizabeth, N. J., after a brief illness. Mr. Lamont was born in Ireland.

W. L. Hutchinson, former state chemist of Mississippi and professor of chemistry at the Mississippi State College, died at his home in Atlanta, Ga., Feb. 16. He was 72 years of age.

Mr. Hutchinson was graduated from Alabama Polytechnic Institute in 1884, and after leaving college he was appointed assistant director of the Louisiana Sugar Experimental Station. Later he became director of the Mississippi Experimental Station at Starkville. For several years he was associated as agronomist at Clemson College in South Carolina. In 1918 he resigned from college work and moved to Atlanta, where he has resided ever since.

Alfred S. Burdick, president of the Abbott Laboratories, died on Feb. 11, after a brief illness from pneumonia. He succumbed almost on his sixty-sixth birthday.

Dr. Burdick was born in New York. In 1886, he graduated from Alfred University and afterwards taught school for a short time. He embarked upon his career by entering the Chicago Medical College and received his medical degree from Rush Medical College, in 1891.

After engaging in medical practice for several years in Illinois and Florida, he became associate professor of the practice of medicine in the Illinois Medical College, and edited several medical journals. In 1904, Dr. Burdick became associated with the Abbott Laboratories, filling a number of positions, until 1920, when upon the death of Dr. W. C. Abbott, he was elected president of the company.

Robert McNeil, founder of the pharmaceutical manufacturing business bearing his name, died unexpectedly of a heart attack Feb. 12 at his home in Philadelphia, Pa. He was 77 years of age. Mr. McNeil was apparently in good health until he was told of the death of Dr. A. S. Burdick, who was an old friend. About an hour after hearing this news he was stricken and passed away almost immediately.

Mr. McNeil graduated from the Philadelphia College of Pharmacy and Science in 1876 and three years later founded the manufacturing business which in recent years has been conducted by his son, Robert L. McNeil.

CALENDAR

American Institute of Chemical Engineers, spring meeting, Chicago, Ill., June 14-16.

American Chemical Society, 85th meeting, Washington, D. C., March 26-April 1.

American Society of Biological Chemists, Cincinnati, Ohio, April 10-12, 1933.

Electrochemical Society, spring meeting, Montreal, May 11-13.

American Petroleum Institute, Tulsa, Okla., May 17-19, 1933.

American Society for Testing Materials, Chicago, Ill., June 26-30, 1933.

National Metal Congress and Exposition, Detroit, Mich., Oct. 2-6, 1933.

Fourteenth Exposition of Chemical Industries, New York, week of Dec. 4-9, 1933.

CHEMICAL ECONOMICS

Operations in the chemical industry in February were lower than in the preceding month and conditions in the early part of March were not favorable for an increase in the rate of activities but with improved credit conditions prospects point to a broader trading movement.

MANY chemical-producing plants did not change their rate of operations in February, but others especially in the latter part of the month, cut down activities and this combined with the reduced number of working days resulted in a total output smaller than that reported for the preceding month. The index number for chemical production for February was 111.2 which compares with the revised number of 115.5 for January.

Falling off in demand for chemicals and related products was reported in February. The rayon industry with output sold ahead was expected to operate at 100 per cent of capacity but requests to defer deliveries of yarn became numerous and this was reflected in a slower rate of production. Production of automobiles also dropped sharply from the January total.

The banking holiday in the first part of March had the effect of increasing demand for some raw materials largely because of a trend toward higher prices. In general, however, production started off in March with some contraction due to uncertainty about payments for goods shipped. More optimistic opinions were expressed, however, and with an improvement in the financial set-up of the country the prospects for a rise in general industrial activity were enhanced.

Following are enumerated data for production in some branches of the chemical industry for January. Consumption figures which are indicative of the rate of activity in the specified industries also are included and comparisons are given for the month preceding and for the corresponding month of last year.

These figures show that in the textile industry consumption of cotton and silk increased in January over December with a slight decline in consumption of wool. The rubber trade likewise made progress in January and output of automobiles gained 21.2 per cent over the total for last December. Production of industrial alcohol was held down during what usually are the largest production months because stocks on hand were large enough to take care of consuming requirements.

Reports compiled by the National Fertilizer Association state that January fertilizer tax tag sales in the 13 Southern States were 20 per cent larger than for January, 1932, but were about 40 per cent smaller than the sales for January, 1931. Ordinarily a number of manufacturers purchase fairly large supplies of tags with the opening of the new year.

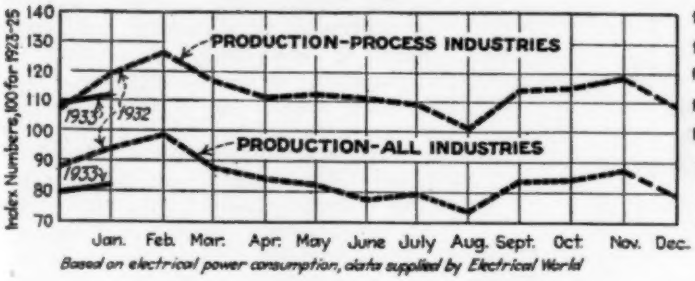
Export and import trade in chemicals necessarily was adversely affected by the financial situation in the early part of the present month. The position of exchange may work out in favor of a larger export business but there is very little indication of a change in the imports unless increased business in domestic markets adds to the call for certain materials of foreign origin.

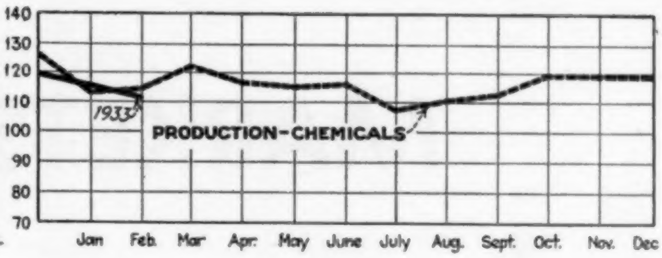
Reports were current recently to the effect that a check-up was being made on exports of nitrate of soda from this country. Exports of this material last year assumed real importance and contracts have been placed this year calling for large shipments abroad. Unless a situation arises which makes it advisable to place an embargo on materials which enter into the manufacture of munitions, there is little probability of any restrictions upon nitrate shipments.

Index numbers used in the graph on page 163 include:

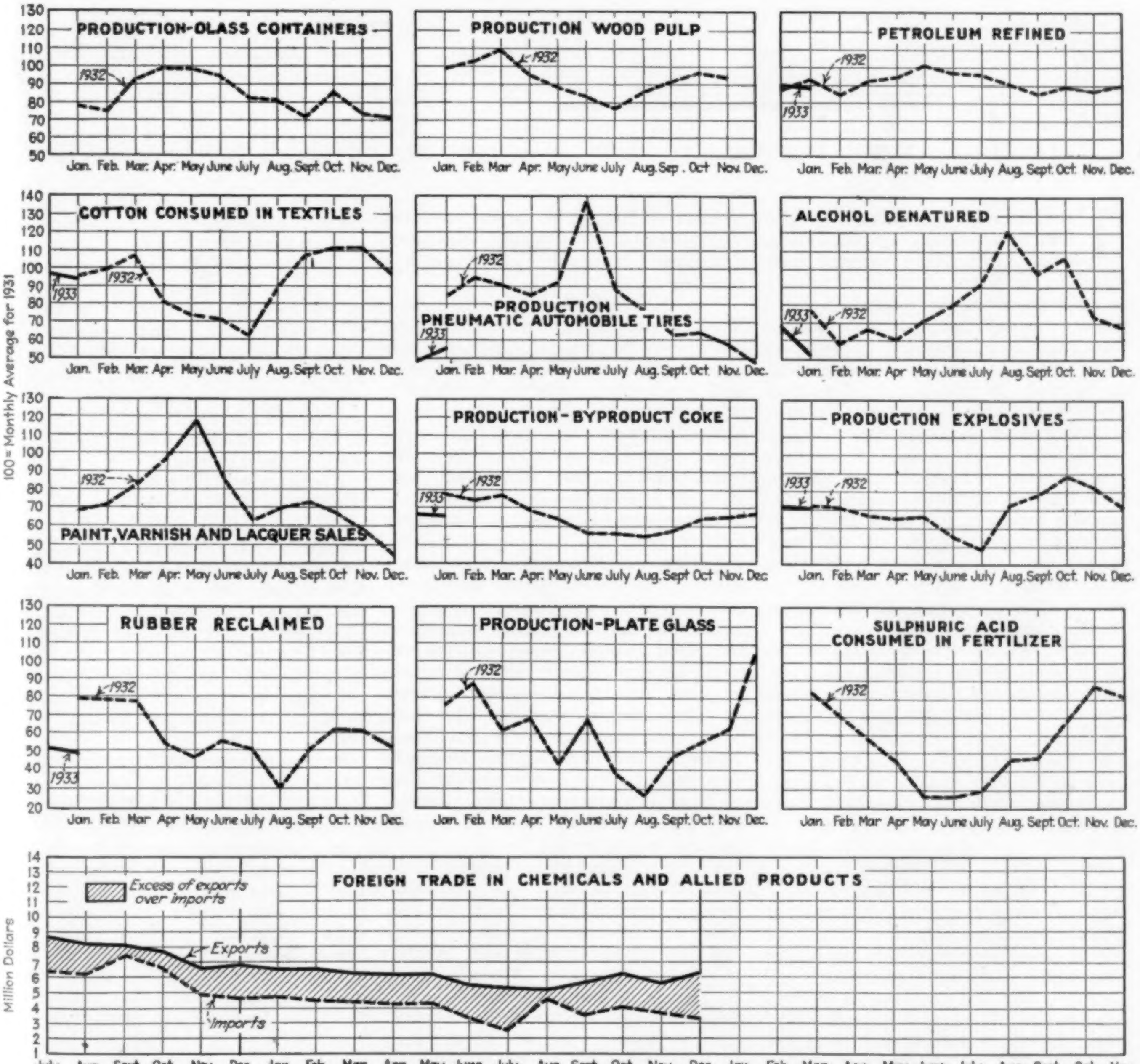
	Jan. 1933
Chemicals	115.5
All Industries	81.9
Process Industries	111.3
Cotton consumed	103.7
Alcohol denatured	53.1
Byproduct coke	65.9
Explosives	70.3
Petroleum refined	88.7
Pneumatic tires	55.6
Rubber reclaimed	48.5

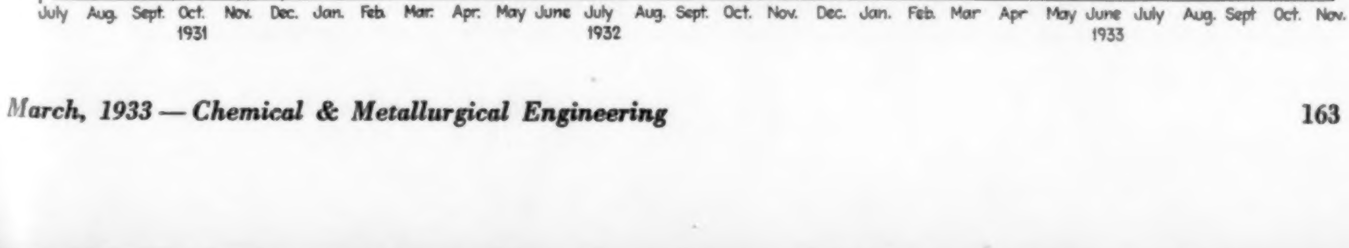
Production	Jan. 1933	Per Cent of Dec. 1932	Per Cent of Jan. 1932
Alcohol, 1000 pr. gal.			
Ethyl	6,014	113.9	45.5
Denatured	2,614	56.6	50.0
Automobiles, no.	130,114	121.2	109.0
Byproduct coke, 1000 ton	1,785	99.9	84.9
Cottonseed oil, 1000 lb.			
Crude	130,699	86.4	70.9
Refined	112,212	83.9	72.1
Petroleum refined 1000 bbl.	66,093	100.1	96.2
Rubber reclaimed, ton	4,983	93.2	61.2
Rosin gum, receipts 3 ports, bbl.	35,064	49.1	122.5
Turpentine receipts 3 ports, bbl.	6,283	39.6	120.0
Rosin wood, bbl.	31,188	106.7	134.4
Turpentine, wood, bbl.	4,975	98.1	137.2
Tires, pneumatic, 1000	1,806	113.9	65.2
Consumption			
Cotton, 1000 bales	471	107.5	108.3
Silk, bales	46,204	113.9	78.6
Wool, 1000 lb.	35,510	97.2	103.7
Fertilizer in South, 1000 ton	205	211.2	119.2
Rubber, crude, ton	21,661	127.5	77.4





TRENDS OF PRODUCTION AND CONSUMPTION





MARKETS

Financial situation spurred demand for basic raw materials and caused price flurry which was extended to chemicals, especially those produced from a metal base. Consumption of chemicals in general was restricted by a slowing up in manufacturing activities. Shipping instructions on contract commitments were withheld in many cases and spot trading was inactive.

TRADING IN chemicals has been variously affected by the conditions which have recently prevailed in the financial world. Inability to make payments for goods because f the banking holiday, apparently had but little effect as the majority of producers were willing to deal with their regular customers. The movement of finished products into the manufacture of which chemicals enter, however, was retarded and this resulted in a slower demand for raw materials and thus directly affected both the volume of deliveries against existing contracts and actual trading in the spot market. Later on, the trend toward an upward swing of prices brought out more active inquiry and, in at least some directions, sellers were inclined to restrict offerings.

Among tariff developments of the month was an announcement of a decrease in import duty on crude sperm oil from 10c. to 5c. a gal. and a decrease in the rate of duty on spermaceti wax from 6c. to 3½c. a lb. No change was made in the present duty of 14c. a gal. on refined sperm oil. The new rates of duty will become effective April 1, 1933. It also was announced that a hearing will be held before the U. S. Tariff Commission in Washington on April 17 when interested parties will be heard concerning alleged unfair methods of competition or unfair acts in the importation or sale of phosphates and apatite. The investigation is directed against the Standard Wholesale Phosphate & Acid Works of Baltimore and Amtorg Trading Corporation, New York, and is being made on the basis of a complaint lodged by the International Agricultural Corporation, Phosphate Recovery Corporation and American Cyanamid Co.

The Magnetic Pigment Co., New York, entered complaint last October, charging unfair competition in the sale of oxides of iron. The Tariff Commission has ordered a public hearing for April 25 and has given an opportunity to the Northern Pigment Co., New Toronto, Canada; Bruce Ross, Ltd., Toronto, Canada; Stanley Doggett, Inc., and C. J. Osborn Co., both of New York, to make written answer under oath on April 10.

Another attempt also is to be made to secure an investigation into foreign and domestic costs of ultramarine blue. Some time ago the Tariff Commission conducted an investigation on this material but found no reason for recommending any change in duty. Since that time, it has developed, the trend of imports has changed so that much of the imported ultramarine blue falls in a price range subject to a 3c. duty and domestic producers claim now that the situation is such as to warrant an increase in the duty.

Changes in freight rates included the establishment of rates on cyanamide, carloads, from Niagara Falls, Ontario, Can., over all routes to points in central territory the same as those in effect on like traffic from Niagara Falls, N. Y., and on the movement of cyanamide from Niagara Falls, Ontario, Can., to southern points rates the same as those in effect on sulphate of ammonia from Niagara Falls, N. Y. Lower freight rates also were granted on shipments of silicate of soda from points in New York.

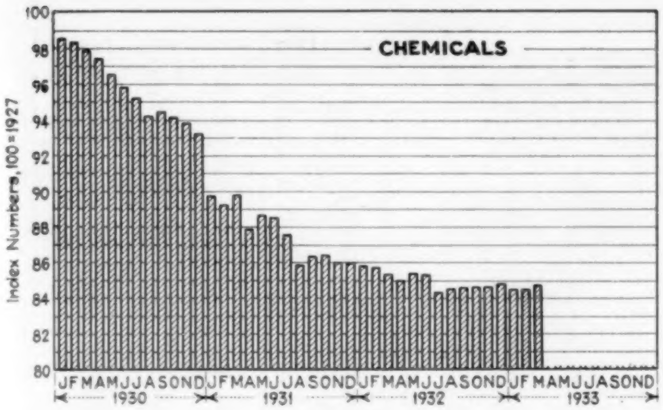
According to unofficial reports a plan is being worked out by the liquidating commission of Cosach under which the constituent companies will be offered the chance to withdraw from the combine. The reported conditions are the return of the securities received and the assumption of the companies debt as well as a part of the debt incurred by Cosach since its incorporation.

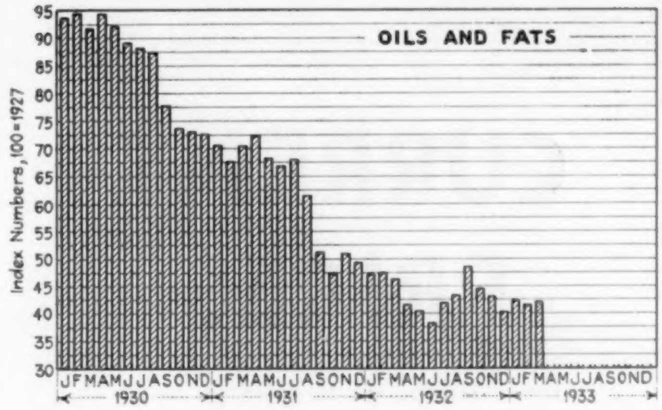
The provisions of law adopted in Chile last month give the liquidating committee specific authority to exercise the powers of the board of directors in conducting the ordinary business of the company; contract obligations through loans or the issue of bonds in national or foreign currency, with or without the guaranty of property of Cosach; conduct all credit, banking and discount operations considered necessary, including customs and insurance operations; enter any necessary contracts for not to exceed five years, and to represent the company in legal matters with all powers of attorney and the special power of compromise. The only restriction of the committee is that it may not give liens of encumbrances on the government's nitrate reserves.

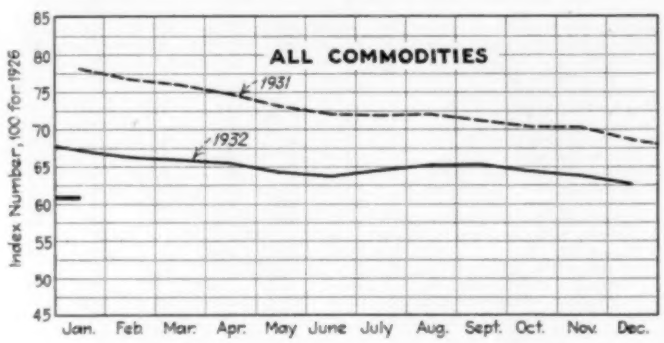
All former government representatives or technical experts who assisted in the formation of Cosach are barred from assisting the liquidating committee. The committee is directed to complete liquidation within two years, members are to receive compensation not to exceed 60,000 pesos each per year, and two of the three members may conduct the work of the commission.

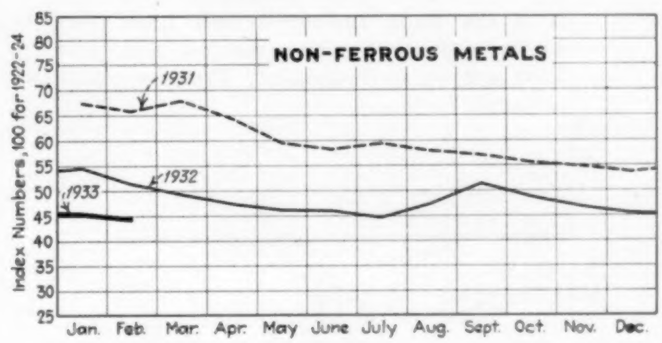
Credits which the committee may obtain during liquidation will have preference over obligations of Cosach contracted prior to the decree of liquidation, under the law. During liquidation Cosach may not be declared bankrupt nor may any attachment be made against its properties, nor may any judicial actions be started on account of obligations incurred prior to liquidation with the exception of wage and accident claims brought by employees in the labor courts.

A report from our consul general at Frankfort-on-the-Main, Germany states that the I. G. Farbenindustrie has placed on the market a solvent which is said to offer important new possibilities for the manufacture of cellulose lacquers, and possibly may lead to a production of brushing lacquers. The product is called "Butoxyl" and is chemically-speaking methylbutylenglycolacetate. Compared with other solvents it comes nearest to butyl acetate, but differs from the latter by its slower rate of evaporation and virtual absence of odor. Its evaporation time comes close to that of ethyl ester of lactic acid.









PRICE TRENDS—CHEM. & MET.'S WEIGHTED INDEXES

RECENT trends in commodity markets have been decidedly in favor of higher prices. Foodstuffs, grains, metals, and other natural products have taken the lead in this movement but the psychological effect is causing extensions to other markets. In some cases a legitimate reason for higher prices is found in the heavier buying movement which was experienced. In other cases increases in value seem to rest on the belief that trading will soon assume larger proportions and the marking up of values is merely in anticipation of an expected shift in the law of supply and demand. It also may be added that considerable influence has been exerted by the opinion that money inflation would lower the purchasing power of the dollar and automatically bring about an upward revision of values.

In the chemical list, the salts depending on a metal base were affected by higher costs for raw materials. Adjustments also were made in the case of many chemical products which previously had been under selling pressure. In some cases this was indicated by actual advances in quotations and in other cases the trading basis drew nearer the open quotation levels with a decrease in price-cutting competition.

Naval stores, linseed oil, and animal fats sold at higher figures and cables from foreign primary points were higher for offerings of oils and in some instances offers were withheld.

While the rising trend of prices no doubt stimulated inquiry for various raw materials and even caused some improvement in transactions, it is not clearly apparent whether the present move is merely a flurry resulting from uncertainty or whether a departure from the low levels of prices which have been prevailing is justified. In all probability the decision will depend on the way manufacturing operations are conducted. For some time it has been held that higher price levels would follow a broadening demand for materials and this view seems to be as well warranted at present as it was a short time ago.

Proposals to use alcohol in gasoline have aroused discussion regarding the possible effect of this on prices for ethyl and the higher alcohols which might be affected. The inference is enlarged consumption would be sufficient to prevent unsold accumulations and the absence of price-cutting would act as a stabilizer on values. Some increase in production costs due to use of different raw materials undoubtedly would be passed on to consumers.

The large output of corn oil which would follow alcohol production from corn would make it necessary to find a wider outlet for that oil. This might have some effect on the general status of the vegetable oil market with the influence toward a lowering of price.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**84.76**
Last month	84.54
March, 1932	85.29
March, 1931	89.72

Increased demand for metals and other basic raw materials strengthened prices for many chemicals. Turpentine was advanced in price and a stronger general undertone was in evidence at the close. Ethyl acetate, acetone, and prussiate of potash sold at lower levels.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	**42.26**
Last month	41.70
March, 1932	46.34
March, 1931	70.57

With market for refined cottonseed oil closed prices at the end of the period were nominal. Sales of crude in the Southeast were reported at higher prices. Linseed oil closed at an advance and the entire market showed a tendency to advance.

CURRENT PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to March 13.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.08½–$0.09	$0.10 –$0.11	$0.10 –$0.11
Acid, acetic, 28%, bbl., cwt.	2.65 – 2.90	2.65 – 2.90	2.75 – 3.00
Glacial 99%, tanks	8.89 –......	8.89 –......	8.10 –......
drs	9.14 – 9.39	9.14 – 9.39	8.35 – 8.60
U. S. P. reagent, c'bys	9.64 – 9.89	9.64 – 9.89	8.85 – 9.10
Boric, bbl., lb.	.04½– .05	.04½– .05	.06½– .07
Citric, kegs, lb.	.29 – .31	.29 – .31	.33½– .35
Formic, bbl., lb.	.10 – .11	.10 – .11	.10 – .11
Gallic, tech., bbl., lb.	.50 – .55	.50 – .55	.50 – .55
Hydrofluoric 30% carb., lb.	.06 – .07	.06 – .07	.06 – .07
Latic, 44%, tech., light, bbl., lb.	.11½– .12	.11½– .12	.11½– .12
22%, tech., light, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Muriatic, 18° tanks, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton.	18.50 –20.00	18.50 –......	18.50 –20.00
Oxalic, crystals, bbl., lb.	.11 – .11½	.11 – .11½	.11 – .12
Phosphoric, tech., c'bys., lb.	.08½– .09	.08½– .09	.08½– .09
Sulphuric, 60°, tanks, ton.	11.00 –11.50	11.00 –11.50	11.00 –11.50
Sulphuric, 66°, tanks, ton.	15.50 –......	15.50 –......	15.50 –......
Tannic, tech., bbl., lb.	.23 – .35	.23 – .35	.23 – .35
Tartaric, powd., bbl., lb.	.20 – .21	.20 – .21	.24½– .25
Tungstic, bbl., lb.	1.40 – 1.50	1.40 – 1.50	1.40 – 1.50
Alcohol, ethyl, 190 p'f., bbl., gal.	2.53½–......	2.53½–......	2.53½–......
Alcohol, Butyl, tanks, lb.	.113–......	.113–......	.143–......
Alcohol, Amyl	......–......	......–......	......–......
From Pentane, tanks, lb.	.143–......	.143–......	.203–......
Denatured, 190 proof			
No. 1 special dr., gal.	.34½–......	.34½–......	.34½–......
No. 5, 188 proof, dr., gal.	.38½–......	.38½–......	.35½–......
Alum, ammonia, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Chrome, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Potash, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Aluminum sulphate, com., bags, cwt.	1.25 – 1.40	1.25 – 1.40	1.25 – 1.40
Iron free, bg., cwt.	1.90 – 2.00	1.90 – 2.00	1.90 – 2.00
Aqua ammonia, 26°, drums lb.	.02½– .03	.02½– .03	.02½– .03
tanks, lb.	.02½– .02¾	.02½– .02¾	.02½– .02¾
Ammonia, anhydrous, cyl., lb.	.15½– .15¾	.15½– .15¾	.15½– .15¾
tanks, lb.	.05 –......	.05 –......	.05½–......
Ammonium carbonate, powd. tech., casks, lb.	.08 – .12	.08 – .12	.10½– .11
Sulphate, wks., cwt.	1.00 –......	1.00 –......	1.00 –......
Amylacetate tech., tanks, lb., gal.	.135–......	.135–......	.16 –......
Antimony Oxide, bbl., lb.	.07 – .08	.07 – .08	.06½– .08
Arsenic, white, powd., bbl., lb.	.04 – .04½	.04 – .04½	.04 – .04½
Red, powd., kegs, lb.	.09 – .10	.09 – .10	.09 – .10
Barium carbonate, bbl., ton.	56.50 –58.00	56.50 –58.00	56.50 –58.00
Chloride, bbl., ton	63.00 –65.00	63.00 –65.00	63.00 –65.00
Nitrate, cask, lb.	.07½– .07¾	.07½– .07¾	.07 – .07½
Blanc fixe, dry, bbl., lb.	.03 – .04	.03 – .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt.	1.75 – 2.00	1.75 – 2.00	1.75 – 2.00
Borax, grain, bags, ton.	40.00 –45.00	40.00 –45.00	50.00 –57.00
Bromine, cs., lb.	.36 – .38	.36 – .38	.36 – .38
Calcium acetate, bags	2.50 –......	2.50 –......	2.50 –......
Arsenate, dr., lb.	.05½– .06½	.05½– .06½	.06 – .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., wks., ton.	18.00 –......	18.00 –......	18.00 –......
flake, dr., wks., ton.	21.00 –......	21.00 –......	21.00 –......
Phosphate, bbl., lb	.07½– .08	.07½– .08	.08 – .08½
Carbon bisulphide, drums, lb.	.05 – .06	.05 – .06	.05 – .06
Tetrachloride drums, lb.	.06½– .07	.06½– .07	.06½– .07
Chlorine, liquid, tanks, wks., lb.	.01¾–......	.01¾–......	.01¾–......
Cylinders	.05½– .06	.05½– .06	.04 – .06
Cobalt oxide, cans, lb.	1.15 – 1.25	1.25 – 1.35	1.35 – 1.45
Copperas, bgs., f.o.b. wks., ton.	14.00 –15.00	14.00 –15.00	13.00 –14.00
Copper carbonate, bbl., lb.	.07 – .16	.07 – .16	.07 – .16
Cyanide, tech., bbl., lb.	.39 – .44	.39 – .44	.39 – .44
Sulphate, bbl., cwt.	3.00 – 3.25	3.00 – 3.25	2.75 – 2.90
Cream of tartar, bbl., lb.	.14½– .15	.14½– .15	.19½– .20
Diethylene glycol, dr., lb.	.14 – .16	.14 – .16	.14 – .16
Epsom salt, dom., tech., bbl., cwt.	1.70 – 2.00	1.70 – 2.00	1.70 – 2.00
Imp., tech., bags, cwt.	1.15 – 1.25	1.15 – 1.25	1.15 – 1.25
Ethyl acetate, drums, lb.	.08½–......	.09 –......	.10 –......
Formaldehyde, 40%, bbl., lb.	.06 – .07	.06 – .07	.06 – .07
Furfural, dr., contract, lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, crude, drums, gal.	1.10 – 1.20	1.10 – 1.20	1.10 – 1.20
Refined, dr., gal.	1.80 – 1.90	1.80 – 1.90	1.80 – 1.90
Glaubers salt, bags, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Glycerine, c.p., drums, extra, lb.	.10½– .10¾	.10½– .10¾	.11½– .11¾
Lead:			
White, basic carbonate, dry casks, lb.	.06 –......	.06 –......	.06½–......
White, basic sulphate, sck., lb.	.05½–......	.05½–......	.06 –......
Red, dry, sck., lb.	.06¾–......	.06¾–......	.06¾–......
Lead acetate, white crys., bbl., lb.	.10 – .11	.10 – .11	.10½– .11
Lead arsenate, powd., bbl., lb.	.09 – .13	.09 – .13	.10 – .14
Lime, chem., bulk, ton.	8.50 –......	8.50 –......	8.50 –......
Litharge, pwd., csk, lb.	.05¾–......	.05¾–......	.05¾–......
Lithophone, bags, lb.	.04½– .05	.04½– .05	.04½– .05
Magnesium carb., tech., bags, lb.	.05¾– .06	.05¾– .06	.05¾– .06
Methanol, 95%, tanks, gal.	.33 –......	.33 –......	.33 –......
97%, tanks, gal.	.34 –......	.34 –......	.34 –......
Synthetic, tanks, gal.	.35½–......	.35½–......	.35½–......
Nickel salt, double, bbl., lb.	.11 – .11½	.11 – .11½	.10½– .11
Orange mineral, csk., lb.	.09½–......	.09 –......	.09½–......
Phosphorus, red, cases, lb.	.42 – .44	.42 – .44	.42 – .44
Yellow, cases, lb.	.28 – .32	.28 – .32	.31 – .32
Potassium bichromate, casks, lb.	.07 – .08	.07 – .08	.08 – .08½
Carbonate, 80-85%, calc. csk., lb	.05 – .05½	.05 – .05½	.05 – .06
Chlorate, powd., lb.	.08 – .08½	.08 – .08½	.08 – .08½
Hydroxide (c'stic potash) dr., lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Muriate, 80% bgs., ton.	37.15 –......	37.15 –......	37.15 –......
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.16 – .16½	.16 – .16½	.16 – .16½
Prussiate, yellow, casks, lb.	.16½– .17	.17½– .18	.18½– .19
Sal ammoniac, white, casks, lb.	.04½– .05	.04½– .05	.04½– .05
Salsoda, bbl., cwt.	.90 – .95	.90 – .95	.90 – .95
Salt cake, bulk, ton.	13.00 –15.00	13.00 –15.00	16.00 –18.00
Soda ash, light, 58%, bags, contract, cwt.	1.20 –......	1.20 –......	1.15 –......
Dense, bags, cwt.	1.22½–......	1.22½–......	1.17½–......
Soda, caustic, 76%, solid, drums, contract, cwt.	2.50 – 2.75	2.50 – 2.75	2.50 – 2.75
Acetate, works, bbl., lb.	.04½– .05	.04½– .05	.05 – .05½
Bicarbonate, bbl., cwt.	1.85 – 2.00	1.85 – 2.00	1.85 – 2.00
Bichromate, casks, lb.	.044– .05	.044– .05	.05 – .06
Bisulphate, bulk, ton.	14.00 –16.00	14.00 –16.00	14.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Chlorate, kegs, lb.	.05½– .07½	.05½– .07½	.05½– .07½
Chloride, tech., ton.	12.00 –14.75	12.00 –14.75	12.00 –14.00
Cyanide, cases, dom., lb.	.15½– .16	.15½– .16	.15½– .16
Fluoride, bbl., lb.	.07 – .08	.07½– .08	.07½– .08
Hyposulphite, bbl., lb.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	3.25 – 3.40	3.60 – 3.75	3.60 – 3.75
Nitrate, bags, cwt.	1.295–......	1.295–......	1.77 –......
Nitrite, casks, lb	.07½– .08	.07½– .08	.07½– .08
Phosphate, dibasic, bbl., lb.	.018– .02	.018– .02	.0255 – .0275
Prussiate, yel. drums, lb.	.11½– .12	.11½– .12	.11½– .12
Silicate (40° dr.) wks. cwt.	.70 – .75	.70 – .75	.70 – .75
Sulphide, fused, 60-62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, cyrs., bbl., lb.	.03 – .03½	.03 – .03½	.03 – .03½
Sulphur, crude at mine, bulk, ton	18.00 –......	18.00 –......	18.00 –......
Chloride, dr., lb.	.03½– .04	.03½– .04	.05 – .06
Dioxide, cyl., lb.	.06½– .07	.06½– .07	.06½– .07
Flour, bag, cwt.	1.55 – 3.00	1.55 – 3.00	1.55 – 3.00
Tin bichloride, bbl., lb.	nom.–......	nom.–......	nom.–......
Oxide, bbl., lb.	.27½–......	.27½–......	.25½–......
Crystals, bbl., lb.	.24 –......	.24 –......	.23½–......
Zinc chloride, gran., bbl., lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Carbonate, bbl., lb.	.10½– .11	.10½– .11	.10½– .11
Cyanide, dr., lb.	.38 – .42	.38 – .42	.41 – .42
Dust, bbl., lb.	.04½– .06	.04½– .06	.05½– .06
Zinc oxide, lead free, bag, lb.	.05¾–......	.05¾–......	.06¾–......
5% lead sulphate, bags, lb.	.05½–......	.05½–......	.06½–......
Sulphate, bbl., cwt.	3.00 – 3.25	3.00 – 3.25	3.00 – 3.25

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.08½–$0.09	$0.08½–$0.09	$0.09½–$0.10
Chinawood oil, bbl., lb.	.05½–......	.05½–......	.07½–......
Coconut oil, Ceylon, tanks, N. Y. lb.	.03½–......	.03 –......	.03½–......
Corn oil crude, tanks, (f.o.b. mill), lb	.03½–......	.03 –......	.03½–......
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.02¾–......	.02¾–......	.03½–......
Linseed oil, raw car lots, bbl., lb.	.076–......	.072–......	.067–......
Palm, Lagos, casks, lb.	.02½–......	.02½–......	.03½–......
Palm Kernel, bbl., lb.	.04½–......	.04½–......	.05½–......
Peanut oil, crude, tanks (mill), lb.	.03½–......	.03½–......	.03½–......
Rapeseed oil, refined, bbl., gal.	.35 – .36	.35 – .36	.39 – .41
Soya bean, tank (f.o.b. Coast), lb.	nom.–......	nom.–......	nom.–......
Sulphur (olive foots), bbl., lb.	.04½–......	.04½–......	.05 –......
Cod, Newfoundland, bbl., gal.	.19 – .21	.19 – .21	.25 – .27
Menhaden, light pressed, bbl., gal.	.25½– .26	.25½– .26	.33 – .34
Crude, tanks (f.o.b. factory), gal.	.09 –......	.09 –......	.20 –......
Grease, yellow, loose, lb.	.02 –......	.02 –......	.02 –......
Oleo stearine, lb.	.04 –......	.03½–......	.04½–......
Red oil, distilled, d.p. bbl., lb.	.06 –......	.06 –......	.06½–......
Tallow, extra, loose, lb.	.01½–......	.01½–......	.02½–......

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb..	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb............	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb..	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb....	.14½- .15	.14½- .15	.14½- .15
Aniline salts, bbl., lb..........	.24 - .25	.24 - .25	.24 - .52
Benzaldehyde, U.S.P., dr., lb....	1.10 - 1.25	1.10 - 1.25	1.10 - 1.25
Benzidine base, bbl., lb.........	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.....	.48 - .52	.48 - .52	.48 - .52
Benzyl chloride, tech., dr., lb....	.30 - .35	.30 - .35	.30 - .35
Benzol, 90%, tanks, works, gal..	.22 - .23	.20 - .21	.20 - .21
Beta-naphthol, tech., drums, lb..	.22 - .24	.22 - .24	.22 - .24
Cresol, U. S. P., dr., lb..........	.10½- .11	.10½- .11	.10½- .11
Cresylic acid, 97%, dr., wks., gal.	.42 - .45	.42 - .45	.49 - .52
Diethylaniline, dr., lb..........	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb..........	.29 - .30	.29 - .30	.29 - .30
Dinitrotoluen, bbl. lb..........	.16 - .17	.16 - .17	.16 - .17
Dip oil 25% dr., gal..........	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.........	.38 - .40	.38 - .40	.38 - .40
H-acid, bbl., lb................	.65 - .70	.65 - .70	.65 - .70
Naphthalene, flake, bbl., lb.....	.04½- .05	.04½- .05	.03½- .04½
Nitrobenzene, dr., lb...........	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb........	.51 - .55	.51 - .55	.51 - .55
Phenol, U.S.P., drums, lb.......	.14½- .15	.14½- .15	.14½- .15
Picric acid, bbl., lb............	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., gal...............	.90 - .95	.90 - .95	1.50 - 1.80
R-salt, bbl., lb.................	.40 - .44	.40 - .44	.40 - .44
Resorcinal, tech., kegs, lb.......	.65 - .70	.65 - .70	.65 - .70
Salicylic acid, tech., bbl., lb.....	.40 - .42	.40 - .42	.33 - .35
Solvent naphtha, w.w., tanks, gal.	.26 -......	.26 -......	.26 -......
Tolidine, bbl., lb...............	.88 - .90	.88 - .90	.86 - .88
Toluene, tanks, works, gal......	.30 -......	.30 -......	.30 -......
Xylene, com., tanks, gal........	.26 -......	.26 -......	.26 -......

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton...	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb...........	.07 - .10½	.07 - .10½	.07 - .14
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb...	.02½- .20	.02½- .20	.03 - .20
Prussian blue, bbl., lb........	.35 - .36	.35 - .36	.35 - .36
Ultramine blue, bbl., lb.......	.06 - .32	.06 - .32	.06 - .32
Chrome green, bbl., lb........	.26 - .27	.26 - .27	.27 - .30
Carmine red, tins, lb.........	3.90 - 4.50	3.90 - 4.50	5.25 - 5.40
Para toner, lb...............	.80 - .85	.80 - .85	.75 - .80
Vermilion, English, bbl., lb.....	1.10 - 1.20	1.10 - 1.20	1.45 - 1.50
Chrome yellow, C. P., bbl., lb.	.15 - .15½	.15 - .15½	.16 - .16½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.07 - .08½
Gum copal Congo, bags, lb......	.06 - .08	.06 - .08	.06 - .08
Manila, bags, lb............	.16 - .17	.16 - .17	.16 - .17
Damar, Batavia, cases, lb.....	.16 - .16½	.16 - .19	.16 - .16½
Kauri No. 1 cases, lb.........	.45 - .48	.45 - .48	.45 - .48
Kieselguhr (f.o.b. N.Y.), ton...	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton...........	40.00 -......	40.00 -......	40.00 -......
Pumice stone, lump, bbl., lb....	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb..........	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.................	4.10 -......	4.00 -......	4.30 -......
Turpentine, gal................	.48½-......	.44½-......	.44½-......
Shellac, orange, fine, bags, lb....	.19 - .20	.19 - .20	.32 - .34
Bleached, bonedry, bags, lb...	.18 - .19	.18 - .19	.24 - .26
T. N. bags, lb...............	.08½- .09	.08½- .09	.12 - .13
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton..	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b Ga.), ton....	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton..	13.75 -....	13.75 -.....	13.75 -.....
Wax, Bayberry, bbl., lb.........	.14 - .15	.14 - .15	.16 - .20
Beeswax, ref., light, lb..........	.20 - .30	.20 - .30	.25 - .27
Candelilla, bags, lb..........	.11 - .12	.10 - .11	.14 -.....
Carnuba, No. 1, bags, lb........	.22 - .23	.21½- .22	.23 - .24
Paraffine, crude			
105-110 m.p., lb............	.03½- .03¾	.03½- .03¾	.03½- .03¾

Price Changes During Month

Advanced	Declined
Benzol	Acetone
Red lead	Ethyl acetate
Litharge	Prussiate of potash
Orange mineral	Ferromanganese
Mercury	
Platinum	
Linseed oil	
China wood oil	
Turpentine	

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton.......	$200.00-.....	$200.00-.....	$200.00-.....
Ferromanganese, 78-82%, ton....	61.00-.....	68.00-.....	75.00-80.00
Ferrochrome, 65-70%..........	.09½-....	.09½-.....	.11-.....
Spiegeleisen, 19-21% ton.........	24.00-.....	25.00-.....	27.00-.....
Ferrosilicon, 14-17%, ton.........	31.00-.....	31.00-.....	31.00-.....
Ferrotungsten, 70-80%, lb.......	.94- 1.00	.94- 1.00	1.00- 1.10
Ferrovanadium, 30-40%, lb.......	2.60- 2.80	2.60- 2.80	3.05- 3.40

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb..........	$0.05½-......	$0.05 -......	$0.06½-.....
Aluminum, 96-99%, lb..........	.229-......	.229-......	.229-......
Antimony, Chin. and Jap., lb.....	.06 -......	.058-......	.06½-......
Nickel, 99%, lb...............	.35 -......	.35 -......	.35 -......
Monel metal blocks, lb..........	.28 -......	.28 -......	.28 -......
Tin, 5-ton lots, Straits, lb........	.24 -......	.235-......	.22½-......
Lead, New York, spot. lb.........	.0335-.....	.03 -......	.03½-.....
Zinc, New York, spot, lb.........	.034-......	.03½-......	.0317-.....
Silver, commercial, oz...........	.27½-......	.25½-......	.30 -......
Cadmium, lb..................	.55 -......	.55 -......	.55½-......
Bismuth, ton lots, lb...........	.85 -......	.85 -......	1.50 -......
Cobalt, lb....................	2.50 -......	2.50 -......	2.50 -......
Magnesium, ingots, 99%, lb......	.30 -......	.30 -......	.30 -......
Platinum, ref., oz...............	30.00 -......	24.00 -......	37.50 -......
Palladium, ref., oz..............	16.00 - 17.00	16.00 - 17.00	19.00 - 21.00
Mercury, flask, 75 lb............	53.00 -......	49.00 - 50.00	70.00 -......
Tungsten powder, lb............	1.45 -......	1.45 -......	1.45 -......

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton.......	$6.50 -$8.25	$6.50 -$8.25	$6.50 -$8.25
Chrome ore, c. f., post, ton........	14.00 -18.50	14.00 -18.50	17.00 -20.00
Coke, fdry., f.o b. ovens, ton......	3.25 - 3.75	3.25 - 3.75	3.25 - 3.75
Fluorspar, gravel, f.o.b. Ill., ton...	17.25 -20.00	17.25 -20.00	17.25 -20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit...........	.19 -......	.19 - ...	.25 - .27
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb..............	.45 -......	.45 -......	.45 -......
Monazite, 6% of ThO_2, ton......	60.00 -......	60.00 -......	60.00 -......
Pyrites, Span. fines, c.i.f., unit....	.13 -......	.13 -......	.13 -......
Rutile, 94-96% TiO_2, lb..........	.10 - .11	.10 - .11	.10 - .11
Tungsten, scheelite, 60% WO_3 and over, unit................	8.00 -10.00	8.00 -10.00	10.50 -12.00

INDUSTRIAL NOTES

LUDLUM STEEL CO., Watervliet, N. Y., has appointed Coolidge Sherman assistant general sales manager. Mr. Sherman has held various positions in the Ludlum sales organization from 1916 to date.

THE COLUMBIA ALKALI CORP., Barberton, Ohio, has announced the appointment of H. W. Gleichert as manager of special product sales to succeed Ray A. Giddings who has left the organization to become secretary of the Calcium Chloride Association.

THE LA BOUR CO., INC., Elkhart, Ind., has opened a direct factory sales office at 24 Commerce St., Newark, N. J. N. A. Pederson has been transferred from the factory to take charge of the new office.

E. I. DUPONT DE NEMOURS & CO. has acquired the insecticide business of Rex Research, Inc., at Toledo and will operate it in connection with Toledo plant of the Grasselli Chemical Co.

JOSEPH TURNER & CO., New York, is now acting as eastern representative for the Colonial Salt Co., Akron, Ohio.

NATIONAL LEAD CO., New York, has elected E. J. Cornish, president of the company since 1916, to the position of chairman of the board of directors and of the executive committee of the company. F. A. Carter succeeds Mr. Cornish as president.

E. F. HOUGHTON & CO., with plants at Philadelphia, Chicago, and Detroit will manufacture and sell the products formerly made by Weaver Brothers Co., Cleveland. J. C. Weaver, formerly vice-president of the latter company is now manager of the cleaner and pickling products department of the Houghton company.

INTERNATIONAL COMBUSTION TAR AND CHEMICAL CORP. has changed its name to the Reilly Tar and Chemical Corp. Offices are maintained at New York, Indianapolis, and Chicago.

ERNEST E. LEE CO., equipment and engineering representatives, Chicago, has admitted Thomas A. Marsh to partnership. For seven years, Mr. Marsh was western engineer for Combustion Engineering Corp. and for three years, president of Modern Coal Burner Co.

NEW CONSTRUCTION

Where Plants Are Being Built in Process Industries

	This Month — Proposed Work and Bids	This Month — Contracts Awarded	Cumulative to Date — Proposed Work and Bids	Cumulative to Date — Contracts Awarded
New England	....	....	$165,000	$80,000
Middle Atlantic	$490,000	$272,000	1,298,000	703,000
Southern	1,868,000	....	2,041,000	181,000
Middle West	40,000	332,000	393,000	495,000
West of Mississippi	287,000	190,000	442,000	836,000
Far West	53,000	....	292,000	328,000
Canada	619,000	....	1,267,000	131,000
Total	$3,357,000	$794,000	$5,898,000	$2,754,000

PROPOSED WORK BIDS ASKED

Chemical Plant — Industrial Laboratories Ltd., Devonshire Rd., Esquimault, B. C., plans the construction of a plant for the manufacture of chemical compounds for waterproofing building materials.

Crayon Factory—Canada Crayon Co., Ltd., Peterborough, Ont., Can., plans to alter and install new equipment in its plant at Lindsay, Ont. Estimated cost including equipment $28,000.

Distillery — Continental Distillers, Ltd., St. Johns, N. F., contemplate the construction of a distillery. Estimated cost $200,000.

Factory—E. I. DuPont do Nemours & Co., Parlin, N. J., plans to alter and enlarge its plant on Washington Rd., Parlin. Estimated cost $40,000.

Fireworks Factory — John Glasspiegel Fireworks Co., 530 North Water St., Milwaukee, Wis., contemplates the construction of a factory for the manufacture of fireworks. Estimated cost $40,000.

Laboratory—Rensselaer Polytechnic Institute, Palmer C. Ricketts, Pres., Troy, N. Y., plans to construct a laboratory addition. Estimated cost $300,000.

Leather Factory—Greenbaum & Collins, Millville, Pa., contemplate the construction of a plant. Estimated cost $80,000.

Paint and Varnish Factory—W. M. Bird & Co., Charleston, S. C., contemplates the construction of a paint and varnish factory. Estimated cost $40,000.

Paper Plant—Guild & Barron, R. A. Barron, Mgr., plans the construction of a straw paper plant here. Estimated cost $50,000.

Porcelain Factory—Porcelain Metals, Inc., M. J. Saltzman, Pres., Sedgewick and Van Brunt Sts., Brooklyn, N. Y., plans the construction of a 1 story factory. H. Ginsberg, 205 East 42nd St., New York, N. Y., is architect. Estimated cost $30,000.

Potash Plant — American Potash & Super Phosphate Corp., Canal Bank Bldg., New Orleans, La., is having plans prepared for four new potash and fertilizer plants — one at Crystal City, Fla., to cost approximately $1,000,000; one at New Orleans, $700,000; one at Mobile, Ala., and one in Texas. L. M. Turnbull, New Orleans, is vice president.

Sulphuric Acid Plant—Canadian Industries, Ltd., Copper Cliffe, Ont., Can., plans an addition to its sulphuric acid plant and nitre cake works, here; also addition to caustic soda works at Sandwich, Ont.

Soda Plant—National Silicates Ltd., Brantford, Ont., Can., plans the construction of a plant for the manufacture of silicate of soda. Estimated cost $55,000.

Radio Tube Plant—Gold Seal Manufacturing Co., Inc., W. E. Duff, in charge, 5 Central Ave., East Newark, N. J., contemplates the construction of a factory for the manufacture of radio tubes at Hull, Quebec. Estimated cost $40,000.

Soap Factory—J. B. Williams Co., Glastonbury, Conn., is having plans prepared for soap factory at Ville La Salle near Montreal, Que., Can. Estimated cost $50,000.

Rayon Plant—Industrial Rayon Corp., Hiram S. Rivitz, Pres., West 98th St. and Walford Ave., Cleveland, O., had plans prepared by Christian, Schwarzenberg & Gaede, Archts. and Engrs., 1836 Euclid Ave., Cleveland, for 1 story, 104 x 220 ft. warehouse addition, 4 story, 41 x 57 ft. preparation building and two 1 story, 35 x 30 ft. fan houses at its plant at Covington, Va. Estimated cost $100,000.

Fuel Oil Plant—Hydro-gas Refineries Ltd., Ste. Catherines, Ont., Can., plans the construction of a plant for the manufacture of motor fuel oil. Estimated cost $100,000.

Oil Plant—Golden Bear Oil Co. Ltd., Oildale, Calif., plans the construction of a plant at King City, Calif., for the manufacture of road oil (treating asphalt base crudes, etc.). Estimated cost $25,000.

Refinery—Bell Oil & Gas Co., Kennedy Bldg., Tulsa, Okla., plans additions to its plant at Grandfield, Okla., to include enlargement of Dubbs cracking unit, additional storage facilities and new treating equipment of present refinery. Estimated cost $100,000.

Refinery — W. C. Goforth & H. D. Landers, Oklahoma City, Okla., contemplate the construction of a refinery at Gladewater, Tex., to have a daily capacity of 2,500 bbl. Estimated cost $100,000.

Refinery — Phillips Petroleum Co., Bartlesville, Okla., plans to construct an addition to its casinghead gasoline plant at Oklahoma City, Okla. Estimated cost $27,000. A. H. Riney, Bartlesville, is engineer.

Refinery—Sinrall Refining Co., Union Central Bldg., Cincinnati, O., and Horse Cave, Ky., contemplates the construction of a refinery to have daily capacity of 2,000 bbl., at Owensboro, Ky.

Refinery—Simrall Refining Corp. of Canada, Henry C. Wade, Ch. Engr., Amherstburg, Ont., contemplates the construction of additional refining units to have daily capacity of 500 bbl.

Refinery—Standard Crude Oil Refining Co., c/o J. S. Friede, Texarkana, Tex., will soon receive bids for the construction of a refinery. Estimated cost to exceed $40,000.

Refinery—Wirt Franklin Petroleum Co., Ardmore, Okla., plans to construct an addition to its casinghead gasoline plant near Oklahoma City, Okla. Estimated cost $20,000.

Machinery—Keasbey & Mattison Co., Thetford Mines, Que., Can., is in the market for asbestos machinery. Address C. H. Shoemaker.

CONTRACTS AWARDED

Cement Plant—Alpha Portland Cement Co., 230 Park Ave., New York, N. Y., plans to alter its cement plant at Olsen, N. Y. Estimated cost to exceed $28,000. Work will be done by separate contracts.

Emulsion Plant—Pontiac Improvement Co., L. P. Bale, Plant Mgr., East 34th St. and Bway., Cleveland, O., awarded contract for an emulsion plant to C. F. Fisher, 3712 Traver Rd., Cleveland. Estimated cost $25,000.

Glass Factory — Standard Glass Mfg. Co., Marion, Ind., awarded contract for a glass factory to Bowman Construction Co., Marion. Estimated cost $29,310.

Gypsum Plant—U. S. Gypsum Co., 561 Richmond Terrace, New Brighton, N. Y., will alter and build additional kiln and furnace structures at its plant here. Work will be done by day labor and separate contracts.

X-Ray Laboratory—Lenox Hill Hospital, 112 East 77th St., New York, N. Y., awarded contract for laboratory to Hegeman-Harris Eng. Co., 360 Madison Ave., New York, N. Y. Estimated cost $50,000.

Laboratories—Board of Public Works, Anderson, Ind., has appointed Allen & Jagtborg, Engrs., Chicago, Ill., to prepare plans for rebuilding waterworks. Will include •2,000,000 gal. reservoir, water treating and chemical laboratories. Estimated cost $175,000. Work will be done by unemployed labor under supervision of engineers.

Leather Factory—Geo. Moser Leather Co., New Albany, Ind., awarded contract for leather factory on Silver St., to Earle Embrey, New Albany. Estimated cost $75,000.

Paint Factory — T. J. Ronan, 17 Atlantic Ave., Brooklyn, N. Y., has leased 5 story factory building at Willow Ave. and East 135th St., New York, N. Y., and will alter and equip same for manufacture of paints, lacquers, etc. Work will be done by day labor and separate contracts.

Rubber Factory—U. S. Rubber Co., J. J. Coughlin, Vice Pres., 1790 Bway., New York, N. Y., awarded contract for alterations to its factory and warehouse at 25-27 Wilkinson Ave., Jersey City, N. J., to Geo. Siegler Co., Inc., 24 Journal Sq., Jersey City. Estimated cost including equipment $28,000.

Factory—National Oil Products Co., Essex St., Harrison, N. J., awarded contract for 4 story factory to Mahoney-Troast Construction Co., 657 Main Ave., Passaic, N. J. Estimated cost $50,000.

Refinery—Continental Oil Co., Continental Oil Bldg., Denver, Colo., awarded contract for skimming and cracking unit at its refinery at Glenrock, Wyo., to M. W. Kellogg Co., 225 Bway., New York, N. Y. Estimated cost to exceed $30,000.

Refinery—Continental Oil Co., Ponca City, Okla., will build cross-cracking stills at its refinery here. Estimated cost $100,000. Work will be done by day labor and separate contracts.

Refinery — Mexican Petroleum Corp., 122 East 42nd St., New York, N. Y., plans the construction of a refinery on Roosevelt Ave., Carteret, N. J. Estimated cost $40,000. A. M. McKeon, c/o Company, is engineer. Work will be done by day labor.

Refinery—Oil Creek Refining Co., Titusville, Pa., awarded contract for distillation plant at refinery to Alco Products Co., 220 East 42nd St., New York, N. Y. Estimated cost to exceed $60,000.

Refinery—White Star Refining Co., 903 West Grand Blvd., Detroit, Mich., awarded contract for grease building at its refinery here to Martin Krausmann Co., 955 East Jefferson Ave., Detroit.

Refinery—C. C. Yeager, Gladewater, Tex., plans the construction of a refinery at Texarkana, Tex. Estimated cost $60,000. Work will be done by day labor.

Timber Treating Plant—Washington-Oregon R.R. & Navigation Co., Portland, Ore., plans the construction of a factory at The Dalles, Ore., for treating timber ties. Estimated cost to exceed $28,000. Work will be done by separate contracts.